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THE EXPANDING HORIZON OF INORGANIC CHEMISTRY[1]

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IT is doubtful if the history of science has ever experienced a broader and more general advancement in an equal period of time than the world has witnessed during the years 1921–1941. Developments in all phases of science have been startling in their scope, their influence upon modern life and in the possibilities which they reveal for still further advancement.

Chemistry has produced or assisted in the production of its full share in these developments. The various branches of chemistry have been busy in expanding their own fields of endeavor and in contributing, as opportunities offer, to the sum total of human progress. So diverse has chemistry become and so technical in its diversity that no modern tries to keep himself informed concerning the developments of the science as a whole because the changes come with bewildering rapidity and in overwhelming numbers. The chemist of to-day feels well satisfied with himself if he can keep abreast of advancing thought in the definite field in which lies his major interest. He must of course be at least dimly conscious of the progress made in adjacent fields and in the realms of the sister sciences. But the modern chemist must be a highly specialized worker in an ever narrowing field in order that he may be able to keep up with his competitors whose training is likewise restricted to an intensive study of limited phases of the subject. It is true that we still insist in our graduate training on a suitable background of prerequisites and minor subjects, but it is quite evident that the background is slowly but surely fading into the remote distance. Perhaps at no time in the history of our educational

[1] President's address, Illinois Chapter of Sigma Xi, May 14, 1941.

system has it been more true that a Ph.D. is "one who knows more and more about less and less."

Chemists have been prone to regard inorganic chemistry as a worked-out field from which nothing new, nothing progressive can be expected. The expression of such a viewpoint indicates that the "background" is in actual fact becoming so dim that it gives quite erroneous impressions of relative values. It is safe to say that inorganic chemistry has made remarkable advances during recent years. Its contributions have been varied, but without these contributing factors much of the advancement in other branches of chemistry and in other sciences as well would be difficult or quite impossible. Inorganic chemistry still furnishes, as it has been doing through the years, the basic facts and theories upon which advancement in other sciences are dependent. For centuries mankind used native metals for making implements and weapons as well as clay for the fabrication of crude utensils, but during these long ages little improvement was made in the manufacture of such objects. In modern times metallurgy and ceramics have extended these processes enormously because of fundamental study concerning the chemical composition of the native materials and of the chemical reactions which take place when these raw materials are subjected to familiar age-old processes. In this intensely practical age in which we live it is easy to forget the fundamental importance of fact and theory. We should recall that few really great advancements have been made in the history of science because of pure chance. Most of our developments have come because some one has combined fact and theory to formulate a new concept, and then persistent effort has been made to convert the dream into an existing and useful product.

Another way in which inorganic chemistry is expanding its horizon is in contributing materials which are essential for progress in various other sciences. New techniques in almost any branch of science require new material with new properties and new abilities. The demands for equipment which will stand up under hitherto impossible conditions are most insistent and very necessary before some one's dream can become a reality. Many times the demand is for the present-day impossibility, but frequently the inorganic chemist has been able to suggest or supply material which will meet the required conditions. In this way chemistry has been able to contribute to the advancement of engineering, agriculture, ceramics, metallurgy, sanitation, medicine, and many other branches of human endeavor as well as to the safety, comfort and convenience of mankind. Sometimes these contributions have been diverted from the paths of the constructive and have been set to work to injure, harass and destroy. But the contributions of inorganic chemistry have shown such a wide diversification in modern life that their occasional misuse must be expected. A list of new materials made available during the past two decades would be impressive, even if its length made it tedious. Among these new materials there are few which could have been furnished without the aid, either directly or indirectly, of the inorganic chemist.

This statement may seem to be a wild and extravagant boast, but I assure you it is made in all modesty. To illustrate its meaning, permit me to cite a few examples from recent experiences. These are listed merely to illustrate the fact that progress is most rapid and most successful when the sciences work together toward a common end. The inorganic chemist is trying to prove that while his contribution may be a humble one, it is nevertheless a very essential part of the picture. In fact, the picture itself might even be wholly impossible were it not for the inorganic contribution, which is all too frequently entirely overlooked.

In 1921 indium was a mere name upon the list of known chemical elements. A certain book, devoted to the chemistry of the so-called "rare" elements, was published in 1923. A most illuminating statement in this book reads: "Indium, one of the rarest of metals, is found in minute amounts in a large number of minerals. The amount never exceeds 1/10 of 1 per cent." Surely an element so rare, so inaccessible, so costly can never expect to become useful outside of the museum collections of the curious and unapproachable. But in 1941 we find a great majority of the dentists in our land using a gold filling containing from ½ to 5 per cent. indium, because this alloy has the most suitable melting range, hardness and strength and is superior in resisting tarnish. Surprising as this change is, it is nowhere near as spectacular as to find full-page advertisements in the engineering magazines lauding the advantages of indium-treated bearings in heavy duty machinery. Such bearings are now easily made by a simple electrolytic deposition from a water solution of the sulfate. By heat-treating the deposit, the indium shows the remarkable property of diffusing into the base metal, thus forming a hard smooth surface which will not peel or chip and which shows remarkable ability to resist the corrosive effects of the free organic acids which are so commonly present in lubricating oils. Only a thin layer of indium is required, a fact which makes it possible to use a metal which still sells for $12 to $15 an ounce. But this price is less than one fifth that asked a few years ago, and further reductions may be expected since the producers of zinc, cadmium, iron, arsenic, antimony, aluminum, magnesium, lead, copper, silver and many other metals are finding it profitable to save their indium residues, since now these find a ready sale at

a good price. As knowledge concerning the handling of indium increases, economies may be expected so that still greater reductions in price will be in order. It is a fact to-day that indium has ceased to be a curiosity and it is now rapidly taking its place as a useful metal.

In 1921 the only useful purpose served by columbium was to fill one space in the Periodic Table. To-day ferro-columbium is a valued article of commerce, highly prized in the production of stainless steel because the presence of one per cent. of columbium "fixes" the small amount of carbon which is unavoidable and permits welding, spinning and drawing of the metal as well as its use in chemical processes at high temperatures. This fact, coupled with the recent development of case-hardening of stainless steel by the so-called nitriding process, has made possible an enormous expansion in the uses of high chromium steels, and it is safe to predict that the future holds numerous possibilities for still greater expansions in the usefulness of these epoch-making materials.

Titanium and its compounds had begun to attract some attention in 1921 and these materials were beginning to be used in the treatment of steel, in various lighting devices, in the dye and ceramic industries, as reagents in analytical chemistry and in the production of smoke screens. Titanium paints had just begun to attract attention. But these uses were largely experimental in character, and none of them except the treatment of steel could be spoken of as having any considerable commercial importance. According to *Mineral Industry*, the production of titanium material in the United States for 1920 amounted to 545 tons of ore and 2 tons of ferrotitanium were imported. In 1939 this country imported over 287,000 tons of ore, an increase of more than 500 fold in the amount of available titanium material. At present TiO_2 finds a rapidly expanding use in making glass, enamels, lacquers, paper, rayon, linoleum, white rubber, printers ink, plastics, tooth paste and face powder. By far the greatest development has come in the production of paints which was begun in Europe about 1919. In 1939 one firm in this country was producing 70 tons of TiO_2 daily, while a rival producer was increasing its output three fold. It is a significant fact that lead paint has been supreme through the centuries, while to-day its leadership is being seriously challenged by titanium.

Beryllium has been pretty much of a problem metal during recent years. Interest in its development has risen at intervals, but the scarcity of the metal and the difficulties connected with its preparation for use have prevented any advancement of a spectacular nature. There has been extensive growth in the utilization of its alloys, especially with copper for both the automobile and the airplane. The hardness, corrosion resistance and non-sparking properties of beryllium alloys have attracted favorable comment in a variety of industries. The use of beryllium metal, which is remarkably hard and elastic, as armor plate for air craft has been so satisfactory that beryllium has been mentioned among the critical materials of modern warfare.

These are a few examples of metals selected from a list of our less familiar elements which have risen from a state of partial or complete obscurity to a point of commercial importance within the past two decades. Many other examples might be given, but a mere enumeration of a few will suffice:

Lithium compounds have gained prominence in ceramics, in air-conditioning systems and in storage batteries. Cesium is considered essential in the manufacture of high-grade radio tubes. Radium is vastly more abundant to-day than it was 20 years ago and its price is a fraction of that which formerly prevailed. Gallium is finding use in high temperature thermometers, in dentistry, and in numerous alloys. The alloys of thallium are among the most resistant metallic substances in the presence of sulfuric, nitric and hydrochloric acids, while its compounds are successful poisons. Zirconium powder is almost ideal as an ammunition primer and it is doubtless playing an important role at the present time in our own preparations for national defense. Molybdenum, formerly regarded as an adulterant in tungsten steel, has now become one of our most important materials in the production of alloy steels. Tantalum, tungsten, vanadium and selenium have all found greater usefulness, while tellurium, long regarded as useless and a nuisance, is gradually finding ways of entering the service of mankind. Neon, a very rare component of the atmosphere, is now in such common use in lighting devices that it can with difficulty retain its position as one of the less familiar elements, although the atmosphere, its only source, contains only 12 ten thousandths of one per cent.

It may not be surprising to find that the usefulness of newcomers among the metals increases rapidly, once methods of utilization have been established. But if we extend our survey to include the most important and best known among commercial metals we shall find some equally impressive developments within the past 20-year period.

Iron is still the giant among the metals, since the latest production figures show that its total world production is more than 25 times that of all other of the common commercial metals combined. Iron has been used since prehistoric times, and there is no metal whose adaptability to an endless variety of purposes has been more thoroughly studied through the ages than has iron. If any metal deserved to have the

reputation in 1920 of offering no inviting problems for the research student, surely it must be iron. But the developments of stainless steel have almost all come since 1920. The use of columbium to permit welding has already been mentioned. Recently the adaptation of the nitriding process to stainless steel produces a metal of outstanding strength, toughness and resistance to corrosion, together with surface hardness and wear resistance of the highest order. This is a material so useful that it is essentially a new metal, capable of innumerable applications. It is doubtful if there has been any more epoch-making development since the introduction of the open hearth than we are now witnessing in the phenomenal growth of stainless steel.

In 1920 the world produced 257,000 metric tons of aluminium. In 1939 the production was nearly three times this amount. During the intervening years, in spite of business depressions and labor disputes, the uses of aluminum have increased at a very rapid rate. Aluminum and its alloys are now used for purposes reaching from kitchen utensils to parlor furniture, from speed boats to airplanes, from truck bodies to stream-lined trains and skyscrapers, from insulating materials to Christmas tree decorations, from food wrappers to electric cables, from paint to high explosives, and from mirrors to permanent magnets. So important has aluminum become in modern life that it was listed in 1939 as one of the 17 strategic materials in United States defense, even though we have for some time ranked second in production and have supplied more than one fifth of the world's aluminum.

In 1921 there were produced in this country a trifle more than 10,000 pounds of the metal magnesium valued at $2.25 per pound; in 1939 there were actually sold more than a thousand times as much and the price had fallen to 27 cents per pound. Because of the rapidly increasing demand for this very light metal, there has recently been put into operation at Freeport, Texas, a $5,000,000 plant for recovering magnesium from sea water. In addition the United States government is investing nine and a quarter million dollars in the building of a magnesium plant upon the west coast for the production of metallic magnesium from Nevada brucite by an entirely new process. When these facilities are completed and if production is equal to prediction the total capacity in this country will approach 25,000 tons per year. This is four times our 1940 production. Magnesium is no longer to be considered as a "rare" metal to be used in small quantities, since now if metals are priced by volume rather than by weight it is the cheapest metal that we know with the exception of zinc and iron.

The production of compact metal from a powder has been practiced for over a century, and the use of powder metallurgy in the preparation of such metals as tungsten, molybdenum and platinum has been practiced for years. But within the past few years these methods have been extended to many other metals and their alloys. Powder metallurgy is found to be convenient if not essential in the working of metals whose melting points are excessive, when metals do not alloy conveniently because of too great differences in melting points, when casting of the metals is not desired and when the product must retain certain properties of the components. This process is now used in making such modern appliances as porous bronze bearings, bearings of high tensile and compressive strength, cemented cutting tools, such as carboloy, and ramet, and the preparation of commutators of flaky copper powder. The use of metal powders in paints, in printers inks, in explosives and in the reduction of refractory oxides may safely be regarded merely as a good beginning in a new type of commercial process.

Gold and silver have been used since time beyond the memory or record of man. They have been symbols of wealth, of exclusiveness and of extremes of selfishness. Their high cost has prevented commercial applications except in a very restricted manner. But present market conditions have brought startling changes in the status of these two metals. Silver at 35 cents per ounce is no longer a precious metal, and as a result it is daily finding new applications which are startling because they are so unexpected. Silver has long been known to possess outstanding properties such as ductility, electrical conductivity and germicidal properties, and we are not surprised to find these uses expanding materially. It is quite natural also to find silver used in the production of metal coatings of various types and thicknesses, including vaporized films and electrolytic deposits. But we are surprised to find silver bearings in our automobiles, and to find the metal used in welding, soldering and in catalysis, sterilization and various other applications. It is perhaps quite significant to note that if our supply of tin is cut off by disturbed foreign commerce a metal commonly suggested as a lining for our food containers is silver. The suggestion seems entirely impractical, but the present price and supply of silver forces upon us the conclusion that this change may come in the not very distant future.

The utilization of gold has been limited through the years to coinage, jewelry and ornamental purposes. This metal has been so useful in these ways that little attention has been given to the discovery of any other commercial applications. But gold and its alloys have some remarkable properties which could be put to use on short notice if the single handicap of high cost could be overcome. Gold is the most

malleable, the most ductile and the most resistant to acid corrosion of all our metals. These properties could be put to work to-morrow. If so large a proportion of the world's gold supply finds its way into American vaults that its use as the basis of exchange between the nations is no longer practical and the European dictators make good their threat to force the world to abandon the gold standard permanently, there need be no fear of gold becoming a useless metal or of finding its only application in cheap jewelry. Chemical industry and our architects would be able to put the entire amount to immediate use and it is safe to predict that once the metal becomes available for commercial uses the demand for its unusual properties will prevent a collapse of the gold market.

Time does not permit consideration of the advances made in the last two decades in the chemistry of hydrogen, of oxygen, or sulfur, of phosphorus, of nitrogen, of chlorine, of bromine, of iodine, of fluorine, of silicon, of boron and of many other materials used by the inorganic chemist. The advances have been, in most cases, gradual and substantial rather than sudden and spectacular. But these changes have made material contributions to modern life. We live longer, we travel more rapidly, we move about more safely, we are more secure, more comfortable, better fed and more effectively protected from contagion and more efficiently cured of disease because the research worker has been busily engaged in expanding the horizons of human knowledge.

Perhaps the most significant fact of all is the knowledge that each of these advances has opened out a new field which is ripe for the investigator. None of these developments must be regarded as complete, but as offering a new avenue for driving back the regions of superstition and ignorance. Inorganic chemistry, then, is not a worked-out field lacking worth-while problems for the research worker, but an area of ever widening interest, which is teeming with opportunity.

In closing may I call your attention to the fact that a survey of this type must either be incomplete or unbearably long. Perhaps it can be provocative without coming too close to either of these undesirable characteristics. If our minds have been stimulated and we are now willing to admit that inorganic chemistry has really made some worth-while advances within recent years and does actually contain some attractive problems which are still waiting solution, then perhaps we are ready to draw the conclusion that the golden age of research lies in the future and not in the past.

THE CONTROLLED EXPERIMENT AND THE FOUR-FOLD TABLE

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SUPPOSE that we are testing the potency of two viruses A and B by injecting dosages of each into six mice and find this result: Five of the mice receiving virus A die and one lives; one of the mice receiving virus B dies and five live. The question is regarding the statistical significance of the result judged by the usual criterion that $P=.05$ is the dividing line between significance and non-significance. Diagrammatically we may draw up the table

	died	lived	total
A	5	1	6
B	1	5	6
Total	6	6	12

As the numbers of mice in the A and in the B series are the same, as is often, if not usually, the case in such experiments, we may compare the numbers $n_A=5$ and $n_B=1$ which died by taking the difference $n_A-n_B=4$. As the number which died in both series together is the same, namely 6, the assumption is made that the chance of death is $p=\frac{1}{2}$ and the chance of survival is $q=\frac{1}{2}$. The question is asked: If $p=\frac{1}{2}$, is the chance for a difference n_A-n_B so great as 4 (without regard to sign) less than .05? The usual method of answering this question is to find the standard deviation of n_A-n_B as $\frac{1}{2}\sqrt{6+6}=\sqrt{3}$, and to consider that the difference is normally distributed with this standard deviation. Since the difference can take only integral values it is assumed[1] that the sum of the probabilities for n_A-n_B as great as 4 is to be found from a table of the probability integral by considering the total area in the two tails beyond 3.5 (not beyond 4) when the standard deviation is $\sqrt{3}$. The ratio of 3.5 to $\sqrt{3}$ is 2.031 and the table gives $P=.0433$. The result is significant, though barely so.

A more careful calculation may be made by actually computing the probabilities for all the combinations of n_A and n_B which will make the difference numerically as great as 4. The chances for various values of n_A and n_B, when multiplied by $(1/2)^{12}$ are:

[1] See, P. R. Rider, "An Introduction to Modern Statistical Methods," pp. 71–72.

n_B \ n_A	6	5	4	3	2	1	0
6	1	6	15	20	15	6	1
5	6	36	90	120	90	36	6
4	15	90	225	300	225	90	15
3	20	120	300	400	300	120	20
2	15	90	225	300	225	90	15
1	6	36	90	120	90	36	6
0	1	6	15	20	15	6	1

Along the main diagonal $n_A - n_B = 0$, along the diagonals next to the main diagonal it is ± 1. The total chance for values as great numerically as 4 is found by adding up the northeast and southwest corners in each of which is

$$(15+36+15)+(6+6)+1=79.$$

Then $2\times 79 \div 2^{12} = .0386$. This is considerably less than the result obtained before, but is exact.

Sometimes one treats the data given by the experiment as a four-fold table and applies Chi-square. If we have a table

	died	lived	total
A	a	b	$a+b$
B	c	d	$c+d$,
Total	$a+c$	$b+d$	N

then $\chi^2 = \dfrac{N(ad-bc)^2}{(a+b)(a+c)(c+d)(b+d)}$.

Moreover in the four-fold table the number of degrees of freedom is 1 and χ is distributed in a normal curve with unit standard deviation so that it is merely necessary to find χ and use a probability integral table.[2] In the particular case under consideration $\chi^2 = 5\ 1/3$, $\chi = 2.309$, and $P = .0208$. This is very much less than the true value .0386. As a matter of fact it is known that if σ be the standard deviation of $n_A - n_B$, we have identically

$$\chi^2 = \left(\frac{n_A - n_B}{\sigma}\right)^2$$

and that the value for P obtained from χ^2 is precisely that which would be obtained from the ratio of $n_A - n_B$ to σ under the assumption that we used the actual value 4, instead of the value 3.5 as above, in forming the ratio; indeed $4/\sqrt{3} = 2.309$.

When the numbers of the four-fold table are small, we are advised to apply χ^2 with the Yates correction, *viz.*,

$$\chi_y^2 = \frac{N(|ad-bc| - \frac{1}{2}N)^2}{(a+b)(a+c)(c+d)(b+d)}.$$

In our case this gives $\chi^2_y = 3$, $\chi_y = 1.732$, and $P = .0832$. This value is very much larger than the others and would, in fact, lead to the conclusion that the results of the experiment were not significant. We may, however, remember that when the numbers in a four-fold table are small, even the Yates correction may fail to give the correct probabilities and we must have recourse to R. A. Fisher's "Exact Method."[3] If this be applied to the present table we have

$$P = 2\,\frac{6!\,6!\,6!\,6!}{12!}\left(\frac{1}{6!\,6!\,0!\,0!} + \frac{1}{5!\,5!\,1!\,1!}\right)$$
$$= 37/462 = .0801$$

Thus the value of P obtained by the exact method of treating the four-fold table, though very near to the value indicated by χ^2_y with the Yates correction, is very far indeed from the values of the probability $P = .0386$ for a difference $n_A - n_B$ as large numerically as 4.

To pass from this illustration to a more general case, if the numbers in the experiment and its control are equal and of value n, and if $p = \frac{1}{2}$, the distribution of $n_A - n_B$ is strictly upon a point-binomial with $\sigma = \frac{1}{2}\sqrt{2n}$ and a range of $2n$, because the sums in the $2n+1$ diagonals of the $n \times n$ square made up of the elements

$$\frac{n!}{k!\,(n-k)!}\cdot\frac{n!}{l!\,(n-l)!},\quad k+l = 0, 1, \ldots, 2n,$$

(as in the case above for $n=6$) are precisely the $2n+1$ binomial coefficients in the expansion of $(x \times y)^{2n}$, as may be seen by multiplying $(x+y)^n(x+y)^n$ and collecting the term $x^{k+1}y^{2n-k-1}$. Thus the exact value of the probability for any run like

	died	lived	total
A	a	b	n
B	b	a	n
Total	n	n	$2n$

may be obtained by summing the first $2b+1$ terms of the point-binomial expansion of $(\frac{1}{2}+\frac{1}{2})^{2n}$ and doubling the result, it being assumed that $b < a$. An approximate result may be obtained by forming the ratio

$$(a - b - \tfrac{1}{2}) : \tfrac{1}{2}\sqrt{2n},$$

provided $b < a$, and looking up the corresponding probability in a probability-integral table.

On the other hand, the exact value of the probability if the table is treated as a four-fold table may be obtained from the series

$$\frac{n!\,n!}{2n!}\left\{1^2, n^2, \left[\frac{n(n-1)}{2}\right]^2, ---, \left[\frac{n(n-1)}{2}\right]^2, n^2, 1^2\right\}$$

of the squares of the coefficients of the binomial expansion of the nth power, by summing the first $b+1$ terms and doubling the result for such is indeed the value of

$$P = 2\,\frac{n!n!n!n!}{(2n)!}\left[\frac{1}{n!n!0!0!} + \frac{1}{(n-1)!\,(n-1)!\,1!1!} + --- \frac{1}{a!a!b!b!}\right].$$

This value of P will be very close to the value determined by figuring Chi-square with the Yates correction, but will be considerably larger than the value of the probability computed for the difference $a-b$ or less.

[2] See Rider, *op. cit.*, p. 112.

[3] See Rider, *op. cit.*, pp. 113–114, or R. A. Fisher, "Statistical Methods for Research Workers," 7th Ed., Art. 21.02.

In the following table are given for a variety of four-fold tables the values of the probability for (1) the difference $a-b$ or greater, (2) the same as estimated from $(a-b-\frac{1}{2}) : \frac{1}{2}\sqrt{2n}$, (3) the given four-fold table or worse by R. A. Fisher's exact method, (4) the estimate by χ^2, (5) the estimate by χ^2_y.

	point-binomial		four-fold table		
	(1) exact	(2) $(a-b-\frac{1}{2})/\sigma$	(3) exact	(4) χ^2	(5) χ^2_y
3, 0 / 0, 3	.031	.041	.100	.014	.103
5, 1 / 1, 5	.0386	.0433	.0801	.0208	.0832
9, 3 / 3, 9	.0226	.0246	.0392	.0141	.0413
18, 10 / 10, 18	.0440	.0450	.0604	.0326	.0613
19, 11 / 11, 19	.0519	.0529	.0698	.0388	.0706

From this table it appears that the value of the probability for a difference as great as $a-b$ may be obtained with a fair degree of approximation from the probability-integral as in column (2); but that the value obtained from χ^2 is far too low and the value obtained from χ^2_y is far too high, as is also that obtained from the four-fold table by the exact method, —even when the numbers in the table are fairly large. Indeed it may be inferred that until the numbers have become so large that the values of P computed from χ^2 and χ^2_y are satisfactorily near together, neither of these values are satisfactory. Even for a table with $a=110$, $b=90$ we have $P=.0456$ from χ^2 and $P=.0574$ from χ^2_y, the former about 11 per cent. below and the latter about 11 per cent. above the true value of P. As an experiment and control are usually run on fairly small numbers it is clear that the data may not be treated by the methods applicable to the four-fold table.

Only the simplest case has been discussed, the one where the numbers (of mice) in the two runs are equal and where the data make $p=\frac{1}{2}$ for experiment and control together. If we have a table such as

	died	lived	total
A	6	2	8
B	1	5	6
Total	7	7	14

for which the numbers are different, but the value of p remains $\frac{1}{2}$, we are already in difficulties. We may not compare the numbers that died but have to compare the proportions $6/8=.75$ and $1/6=.167$. The value of χ^2 leads to $P=.0308$ whereas that of χ^2_y leads to $P=.1052$. If we compute the chance of an equally bad four-fold table by the exact method we have $P=.1026$ which is close to the value given by χ^2_y. If we obtain $p_A-p_B=7/12$ and its standard deviation $\sigma=\sqrt{42}/24$ and their ratio $\sqrt{42}/3=2.160$ we come back, as we must, upon the value $P=.0308$ given by χ^2.

To find the actual distribution of p_A-p_B it is necessary to form the products

$$\frac{1}{2^6}\,\frac{6!}{k!(6-k)!}\cdot\frac{1}{2^8}\,\frac{8!}{l!(8-l)!}$$

for all values of k from 6 to 0 and of l from 8 to 0 and to collect the results according to p_A-p_B, of which the values advance by $1/24=.04167$. The distribution is, of course, symmetric; it turns out to be as follows for positive values of p_A-p_B:

$24(p_A-p_B)$	0	1	2	3	4	5	6	7	
2^{14} chance	1402	888	588	1128	1056	456	588	840	
$24(p_A-p_B)$	8	9	10	11	12	13	14	15	
2^{14} chance	435	216	420	336	90	120	168	56	
$24(p_A-p_B)$	16	17	18	19	20	21	22	23	24
2^{14} chance	15	48	28	0	6	8	0	0	1

It will be observed that the distribution is not unimodal but very irregular. The particular value of p_A-p_B given in the table is 14/24. Summing the actual chances we have 330 for positive values as great as 14/24 and the same for negative values, so that the true value of P for so large a difference in the proportion of deaths in experiment and control is $P=660/2^{14}$, which is .0403, and the difference is significant. As the distribution is centered at the multiples of 1/24, it would seem as though we should use instead of 14/24 for p_A-p_B the value $14/24-\frac{1}{2}/24=27/48$ relative to $\sigma=\sqrt{42}/24$ when consulting a table of the probability-integral. The resulting value of P is .0373, which is not far from the value obtained by summation.

We must not, however, expect that any simple modi-

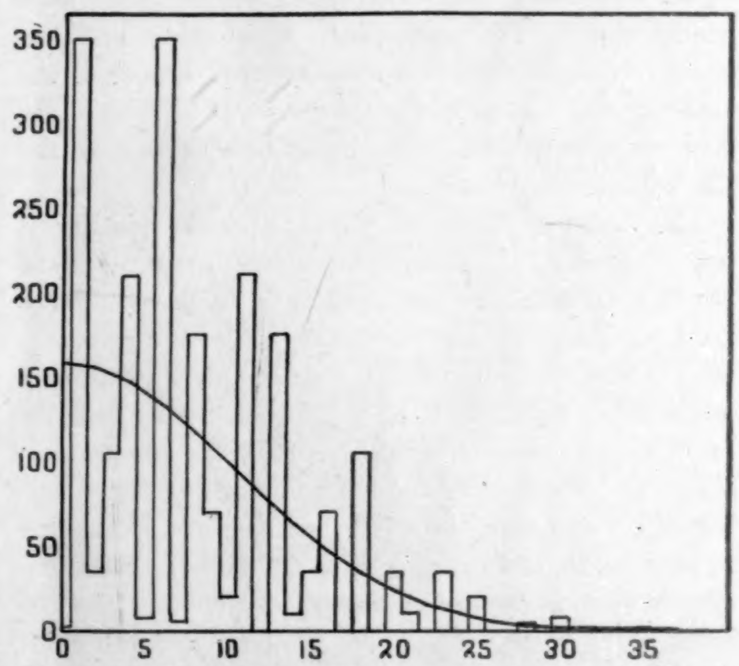

FIG. 1. Histogram of the chance ($\times 2^{12}$) for different values of p_A-p_B ($\times 35$) when there are 7 animals in one series and 5 in the other, with $p=q=\frac{1}{2}$, and normal curve of the same standard deviation.

fication of $p_A - p_B$ will afford, relative to σ, a value as a normal deviate which will give a good value for P, because the great irregularity in the distribution of $p_A - p_B$ makes it impossible to fit any normal curve at all closely to the values of the chances for different values of $p_A - p_B$. Fig. 1 shows the distribution when we have 7 in one series and 5 in the other, where the differences advance by 1/35, and also the normal curve which "fits" in the sense that its standard deviation is that of $p_A - p_B$. With the great oscillations on the two sides of the curve, it must be clear that the summation of the chances to a given abscissa can not be expected to be closely equal to the area under the curve.

It may be remarked that for the experiment with its control we do not logically have a four-fold table to be treated as that table usually is treated. What we have is two independent point-binomials. Moreover, what a χ^2-table gives us is the chance for an observed table as bad as we have, *i.e.*, for one of equal or less probability (apart from fluctuations due to small numbers). But the probabilities of the different tables are not in the same serial order as the differences $p_A - p_B$ in the different tables. Hence there is neither logical nor arithmetic likelihood that the use of χ^2 should solve well our problem of determining whether the effects of treatment in experiment and control are statistically significant. It is still true, of course, that if numbers are sufficiently large, χ^2 will give the correct probabilities, but they have to be larger than is customary in such experiments.

SCIENTIFIC EVENTS

THE SCIENTIFIC EHIBITION AT DALLAS

THE American Association for the Advancement of Science, under the presidency of Dr. Irving Langmuir, associate director of research of the General Electric Company, will meet at Dallas, Texas, from December 29, 1941, to January 3, 1942, inclusive.

Fourteen sections of the Association and twenty-nine of its associated and affiliated groups will actively participate in the meeting. Among these groups will be the American Society of Zoologists, the Botanical Society of America, the American Society of Naturalists, the American Phytopathological Society, the Genetics Society of America, the American Meteorological Society and the American Society of Parasitologists.

The Adolphus and Baker Hotels, located diagonally across the street from each other, will serve as joint headquarters. The association registration and the annual exhibition will be on the mezzanine floor of the Baker Hotel. Most of the sessions will be held in the downtown section of Dallas, many being scheduled for the headquarters hotels.

The Texas Academy of Science and the Southwestern Division of the association, active in preparations for the meeting, are anticipating a large attendance from southwestern United States. The vast resources of this area, including cheap natural gas, and its easy accessibility to all parts of the United States have attracted large industries, and defense operations have stimulated many older industries, including the smelting of tin and zinc, the mining of mercury, extraction of magnesium and bromine from sea water; production of toluol, manufacture of paper, of airplanes and the building of ships. Scientists in these and other industries will contribute to the program of the meeting, and it is expected that many of the industries will be represented at the exhibition.

Announcements and diagrams of the exhibition hall will be mailed to prospective exhibitors at the end of June. For information regarding exhibits, write to the undersigned, 3941 Grand Central Terminal, New York, N. Y.

DORIS LEISEN,
Director of Exhibits

THE PEARL DIVERS GROUP IN THE AMERICAN MUSEUM OF NATURAL HISTORY

THE new Pearl Divers Group in the Hall of Ocean Life at the American Museum of Natural History was opened on June 10. It was constructed under the direction of Dr. Roy Waldo Miner, curator of the Department of Living Invertebrates. It represents an underseas scene in the enclosed pearl lagoon of the coral atoll of Tongareva—a small ring-shaped island in the South Seas about 2,000 miles due south of Honolulu.

Through the large central opening of the group, which measures 35 feet across the front, 12 feet in depth and 14 feet in height, two Tongarevan pearl divers are depicted plunging down into a coral gorge beneath the water's surface.

One of the central features of the group is a cluster of pearl oysters adhering to the coral of the sea bottom. One of the native divers is gathering oysters to bring them to the surface, while the other is swimming down to reach the oyster bed. These are the large pearl oysters, with shells six to eight inches in diameter, that the world uses for knife handles, buttons, inlays and other decorations.

A bed of *Tridacna* clams (known as "man-trap" clams) is half buried in the rocky slope which rises to the cliff-like coral wall at the left, their sinuous openings gaily festooned with brightly colored mantle edges. This species of *Tridacna* is smaller than the

clams of the Great Barrier Reef, that weigh several hundred pounds, but even the smaller variety is dangerous to the unwary diver who has a foot or hand caught between the shells.

The Pearl Divers Group emphasizes the delicate beauty of the corals of the South Seas, the many varieties ranging through all the vivid colors of the rainbow—from rose to lavender, purples, blues and tans. Besides the hundreds of other brightly colored fishes which swim singly or in schools, the group contains vicious needle-toothed morays, lurking in crevices. These dangerous eel-like fishes bite at anything that comes near.

To simulate the shimmering under-surface of the water as a diver sees it from 25 feet or more underseas, sheets of chrome-plated copper were installed at the top of the group after several other materials had been considered by Dr. Miner to produce this effect. This also presented another engineering problem, for the contact of these sheets with the iron framework that supports the coral cliffs would cause them to corrode within a fairly short time. Dr. Miner solved this by attaching the chromed copper to the framework by means of aluminum supports—thereby guaranteeing the life of the roofing as long as the group exists. Air-shafts, leading from the group to open spaces underneath the balcony of the Hall of Ocean Life, also insure the preservation of the contents.

The Pearl Divers Group is the gift of the late Edith Haggin De Long, whose generosity made possible, not only the modeling and assembling of the group itself, but also the mural by Francis Lee Jacques on the gallery floor immediately above.

The expeditionary work for the group, under the leadership of Dr. Miner, was made possible through the cooperation of Templeton Crocker, of San Francisco, who accompanied the expedition and placed at the museum's disposal the facilities of his schooner yacht, the *Zaca*, at Tongareva. Contributions for this expedition were also made by Junius S. Morgan, George T. Bowdoin, Clarence L. Hay and Wyllys Rosseter Betts, Jr. The personnel of the museum consisted of Dr. Miner, leader, Mr. Betts, field associate, and Chris E. Olsen, departmental artist and modeler.

INDUSTRIAL RESEARCH

AMERICAN industry spends six per cent. of its net income on industrial research and has increased its research personnel forty-one per cent. in the last two years, according to a report on industrial research by the National Resources Planning Board which has been transmitted to Congress by President Roosevelt. It covers all phases of industrial research in the United States and is the second in a series on Research Resources of the Nation prepared by the board with the assistance of scientific councils and committees. The National Academy of Sciences and the National Research Council are responsible for the preparation of the present volume. Its conclusions are drawn from an extensive survey in which 2,350 companies reported 70,033 persons engaged in technical research in American industry at an average annual cost of $300,000,000.

Significant facts developed by the survey are:

> The rate of increase of research personnel during the last two years is twice the average rate for the last twenty years.
>
> The contribution by newly established laboratories to the increase of research employment within the last two years is insignificant.
>
> Of the total research personnel reported, slightly more than half are professionally trained, principally as chemists and engineers. The remainder is about equally divided between technical and nontechnical workers.
>
> A considerable number of small and medium-sized companies conduct research. However, most of the industrial research effort, as measured by personnel, is supported by a comparatively small number of large corporations.
>
> In general, viewing industrial research as a national asset, its rapid growth in those areas where it is already established is most gratifying. The rate of expansion into additional areas appears to be decreasing rather than increasing. There remains a number of industries to which research methods could almost certainly be applied with profit on a larger scale than they now are. Finally, the total volume of industrial research being conducted by small and medium-sized companies is relatively small, as measured in terms of personnel.

In 1938 the largest number of research workers was employed in the chemical and allied industries. Next were petroleum, electrical communications, electrical machinery, apparatus and supplies, other machinery industries and rubber products. In that year more than half of those working in industrial research laboratories in the United States were employed by the chemical and petroleum industries and by the electrical industry, including communications, utilities, radio and the manufacture of electrical machinery, apparatus and supplies.

A breakdown of the professionally trained persons engaged in industrial research is as follows: chemists, 15,700; engineers, 14,980; physicists, 2,030; metallurgists, 1,955; biologists and bacteriologists, 1,955; other professions, 909—a total of 36,553. In other technical, administrative and clerical positions 33,480 persons were employed.

Commenting on close cooperation between government and private research agencies the report says:

> The Federal Government maintains a large number of research laboratories from which help may be obtained in conducting research along lines that promise results re-

dounding to the public good. For instance, the laboratories of the Bureau of Agricultural Chemistry and Engineering have been most helpful in working out problems of general interest. The four new regional research laboratories now under construction by the United States Department of Agriculture will no doubt be anxious to render similar assistance under suitable cooperative arrangements.

The government agency most frequently called upon to aid trade-association research is probably the National Bureau of Standards. This agency, as its name implies, is most important in standardization research, but arrangements can be made with it to supply research associates for work on particular industrial problems. More often, however, a grant in money is made to the bureau to provide funds for a specified task. One particularly important phase of the bureau's work is the preparation and distribution of standard analytical samples and standard test specimens. The analyses and physical properties are carefully determined by the bureau so that they can be used by individual laboratories to check the accuracy of their own methods and determinations.

SUMMER COURSES IN APPLIED MECHANICS AT BROWN UNIVERSITY

A STAFF of sixteen experts from Europe and America, representing "the best men available in the fields of mathematics, engineering and physics," has been selected to take charge of summer instruction and research in applied mechanics at Brown University, where special problems in defense industry will be studied by prospective defense technicians. Beginning on June 23 and continuing through September 13, the summer session is designed to help overcome a bottleneck in the supply of men with highly specialized knowledge who are needed in defense industry.

The first program of its kind will bring together, according to a statement made by Dr. R. G. D. Richardson, dean of the Graduate School, those "who are now so widely scattered that their work is relatively ineffective for instruction purposes." The courses to be offered will deal largely with higher mathematics. They will include "Partial Differential Equations," "Fluid Dynamics," "Elasticity," and seminars in fluid dynamics and elasticity. The personnel of the staff has been chosen "for their practical knowledge and experience, the high degree of their past achievements; and their grasp of the fundamental problems in mathematics which are related to defense preparations."

There will be six full-time professors and ten visiting lecturers. In the group of professors, one is Polish, two are Russian and three are German by birth. The German specialists are among those who have left their native country since Hitler's rise to power and whose outstanding achievements in applied mechanics have helped bring about the high quality and efficiency of Nazi planes and other fighting equipment.

The professors are:

Richard von Mises, now lecturer on aerodynamics and applied mathematics at Harvard University, and formerly director of the Institute for Applied Mathematics at the University of Berlin. One of the most eminent European authorities on aerodynamics, hydrodynamics and the theories of elasticity and probability, von Mises is known particularly for his studies of airplane body shapes and vibrations. His book on aeronautics has gone through five editions.

Kurt O. Friedrichs, professor of mathematics at New York University and formerly professor of mathematics at the Technological Institute at Braunschweig. He is widely known for his work in applied mathematics, including his mathematical investigations of the stresses on thin metal plates, like those used in airplane construction.

Ivan S. Sokolnikoff, professor of mathematics at the University of Wisconsin and expert for the National Defense Research Committee. He is known for his work in the theory of elasticity, mathematical physics, partial differential equations and boundary value problems.

Jacob D. Tamarkin, professor of mathematics at Brown University, formerly professor of mathematics at the University of Petrograd and the Petrograd Electrotechnical School. An editor of the international journal, *Mathematical Reviews*, his field is pure mathematics, particularly the Fourier Series and Laplace integrals.

Willi Prager, professor of engineering at the University of Istanbul, formerly associated with the Aerodynamical Institute of Göttingen. He is a world-recognized authority on structural statics, the theory of vibrations, hydrodynamics and the theory of plasticity.

Stefan Bergmann, lecturer at the Massachusetts Institute of Technology and formerly instructor at the Institute for Applied Mathematics at the University of Berlin. His specialized studies deal with applied mathematics, the theory of elasticity, fluid dynamics and electromagnetic theory.

The lecturers will include Professor R. D. Courant, mathematics, New York University; R. M. Foster, Bell Telephone Laboratories; Dr. Thornton C. Fry, mathematical research director, Bell Telephone Laboratories; Professor James N. Goodier, mechanics of engineering, Cornell University.

Professor Robert B. Lindsay, physics, Brown University; Dr. A. L. Nadai, mechanical engineering, Westinghouse Electric and Manufacturing Company; Dr. Hillel Poritzky, mathematician, General Electric Company; Dr. Theodore Theodorsen, chief, physical research division, National Advisory Committee for Aeronautics, Langley Field.

Professor Stephen P. Timoshenko, theoretical and applied mechanics, Stanford University; Professor Norbert Wiener, mathematics, Massachusetts Institute of Technology.

THE UNIVERSITY OF CHICAGO FIFTIETH ANNIVERSARY SYMPOSIA

A CORDIAL invitation is extended to scholars and scientific men to attend a series of Symposia with the general title "New Frontiers in Education and Research" in celebration of the fiftieth anniversary of

the University of Chicago next September. The program comprises sections in the Divisions of the Biological Sciences (including the Medical School), the Humanities, the Physical Sciences and the Social Sciences, the Law School and the School of Social Service Administration. The School of Business participates in the program of the Social Sciences and the Divinity School in that of the Humanities.

Nearly all the symposia will be held during the five days from September 22 to 26. The American Association for the Advancement of Science will meet at the University of Chicago during this period, and the symposia in the sciences will be under the joint auspices of the university and the association. The symposia of the university on Respiratory Enzymes and the Biological Action of the Vitamins (September 15 to 17) and the Training of Biologists (September 18 to 20) will be held in advance of the meeting of the American Association for the Advancement of Science.

The following societies, in addition to the American Association for the Advancement of Science, have accepted an invitation to hold meetings at the university in September, and copies of their announcements will be sent on request: September 2–6, the American Mathematical Society, the Mathematical Association of America, the Econometric Society, the Institute of Mathematical Statistics and the Sixth International Congress for the Unity of Science; September 7–10, the American Astronomical Society at Yerkes Observatory, Williams Bay, Wisconsin; September 25, 26, the American Meteorological Society.

In view of the limited capacity of the lecture halls, those who desire to attend should send their names and addresses as soon as possible, and indicate the particular sessions in which they are interested.

The student resident halls of the university, all of which are exclusively for men or for women, and International House, which has separate sections for men and for women and a common dining-hall, will be available, up to their capacity, at the rate of $2.00 per day for room and breakfast or $3.00 per day for room and all meals. Reservations will be made in the order of receipt of applications. Applications must state precisely the period for which a reservation is desired.

There are a number of good hotels within a radius of two miles from the university, including the Chicago Beach Hotel, Del Prado Hotel, Shoreland Hotel and Windermere East Hotel. In addition there are a number of residential hotels. All inquiries should be addressed to The Director of the Fiftieth Anniversary Celebration, The University of Chicago, Chicago, Illinois.

AWARD OF THE MEDALS OF THE AMERICAN MEDICAL ASSOCIATION

The gold medal of the American Medical Association, given annually for exhibits based on individual investigations, was presented on June 4 at Cleveland to Professor A. C. Ivy, of the Northwestern University Medical School, and his associates, Drs. Alvin L. Berman, F. S. Grodins, H. Wigodsky, B. Phibbls and A. J. Atkinson, for their exhibit demonstrating the proper use of bile salts in disorders of the liver and the gallbladder. The silver medal was awarded to Drs. Harold Thomas Hyman, William Leifer and Louis Chargin, of Mount Sinai Hospital, New York, for an exhibit describing massive dose chemotherapy of early syphilis by the intravenous drip method. The bronze medal was awarded to the Mayo Foundation group, of Rochester, Minn., for investigations into physiological problems in aviation medicine conducted by Dr. Walter M. Boothby, Dr. W. R. Lovelace, Dr. C. W. Mayo and Dr. A. H. Bulbulian.

Three medals were given for exhibits not devoted to experimental investigations; of these the gold medal was awarded to Dr. Waltman Walters, Dr. Howard K. Gray and Dr. James T. Priestly, of the Mayo Clinic, for an exhibit on cancer of the stomach, demonstrating the importance of early treatment. The silver medal was received by Dr. Grover C. Penberthy and Dr. Charles N. Weller, of the Children's Hospital of Michigan and the Wayne University College of Medicine, for an exhibit illustrating the treatment of burns, and a bronze medal was presented to Dr. G. V. Brindley, of the Scott and White Hospital, Temple, Texas, who illustrated operations for cancer of the colon. There were also four certificates of merit and six honorable mentions in this group of exhibits.

RECENT DEATHS

Dr. Lee Abram Strong, since 1934 chief of the U. S. Bureau of Entomology and Plant Quarantine, died on June 2. He was fifty-four years old.

Thomas Ulvan Taylor, dean emeritus of the College of Engineering of the University of Texas, died on May 23 at the age of eighty-three years. He joined the university as professor of mathematics in 1888.

Dr. Albert Graeme Mitchell, professor of pediatrics at the University of Cincinnati, director and chief of staff of the Children's Hospital, died on June 1. He was fifty-two years of age.

Dr. Claude Hale Birdseye, topographer, explorer, geographer, and chief of the division of engraving and printing of the U. S. Geological Survey, died on May 30 at the age of sixty-three years.

Nature records the following deaths: Francis Druce, the well-known botanist, honorary treasurer of the Royal Meteorological Society during 1913–18 and 1925–32, and of the Linnean Society during 1931–40, by enemy action, and Dr. F. Francis, emeritus professor of chemistry at the University of Bristol, on April 15.

SCIENTIFIC NOTES AND NEWS

THE distinguished service medal for scientific achievement of the American Medical Association was presented at the opening general meeting at Cleveland on June 4 to Dr. James Ewing, an authority on cancer, formerly director of the laboratories of Memorial Hospital, New York City.

THE Arthur Hoyt Scott horticultural award of Swarthmore College, consisting of a medal and $1,000, has been given to Dr. C. Stuart Gager, director of the Brooklyn Botanical Gardens. The award was made in recognition of "achievement of great merit and recognition of outstanding work in creating and developing a wider interest in gardening." Swarthmore College is the custodian of the funds of this endowment, and the president of the college acts as chairman of a committee of nine that makes the award. The committee includes representatives of various horticultural organizations.

DR. ELMER D. MERRILL, administrator of botanical collections and director of the Arnold Arboretum of Harvard University, has been elected an honorary member of the Royal Agricultural and Horticultural Society of India.

THE Stevens Institute of Technology on June 7 conferred the degree of doctor of science on Dr. Percy Williams Bridgman, Hollis professor of mathematics and natural philosophy at Harvard University.

DR. OTHMAR HERMAN AMMANN, formerly chief engineer of the Port of New York Authority, received on June 3 the honorary degree of doctor of science at the commencement exercises of Columbia University. The citation reads: "Formerly chief engineer of the Port of New York Authority; graduated at the Swiss Federal Polytechnic Institute of Zurich, receiving there the traditionally sound and thorough scientific training of the land of his birth; who has now established a commanding reputation among bridge engineers through his leading part in planning and in building the great bridges which unite Manhattan Island with its neighbors."

THE doctorate of science was conferred on June 2 at the commencement exercises of Syracuse University on Dr. Elmer Grimshaw Butler, professor of biology and chairman of the department at Princeton University; and on Alger Luman Ward, manager of the chemical laboratories of the United Gas Improvement Company, Philadelphia.

THE degree of doctor of laws was conferred on June 1 by the New Jersey College for Women, Rutgers University, on Dr. Margaret Mead, assistant curator of ethnology at the American Museum of Natural History, who gave the commencement address.

MRS. CECILIA PAYNE GAPOSCHKIN, astronomer at the Harvard College Observatory, received on May 10 the degree of doctor of science at the seventy-first annual commencement exercises of Wilson College, Chambersburg, Pa.

AT the forty-eighth annual commencement exercises on June 4 of the New Jersey College of Pharmacy, a division of Rutgers University, the doctorate of science was conferred on Rudolf Edward Gruber, of Colonia, N. J., vice-president of Merck and Company.

DR. DONALD PRICE, technical director of the Organic Research Laboratory of National Oil Products Company, Harrison, N. J., has been elected chairman of the New York Chapter of the American Institute of Chemists. He succeeds Dr. William Howlett Gardner, of the Polytechnic Institute of Brooklyn.

DR. RALPH H. MÜLLER, professor of chemistry at New York University, was elected chairman of the New York Section of the American Chemical Society at the annual meeting of the section on May 9. He succeeds Robert Calvert, consulting chemist and chemical patent attorney. Dr. Charles N. Frey, Fleischmann Laboratories, New York, was named chairman-elect.

THE Case Chapter of the Society of Sigma Xi held its annual initiation on the evening of May 29. Twenty-nine students were elected to full membership. Officers elected for the next year were: *President,* Professor Paul L. Hoover; *Vice-president,* Professor Kenneth H. Donaldson; *Treasurer,* Professor T. M. Focke; *Secretary,* Professor Richard S. Burington. Following the ceremonies at which Professor Robert S. Shankland, retiring president, presided, Professor Bart J. Bok, of Harvard University, spoke on "In Between the Stars."

AT the anniversary meeting of the members of the Royal Institution, London, held on May 1, the following officers were elected: *President,* Lord Eustace Percy; *Treasurer,* Sir Robert Robertson; *Secretary,* Major Charles E. S. Phillips.

DR. ROBIN C. BUERKI, medical superintendent of the General Hospital of the State of Wisconsin, at Madison, has been appointed dean of the Graduate School of Medicine of the University of Pennsylvania to succeed Dr. George H. Meeker, who will retire on October 1. In addition Dr. Buerki will fill the newly established position of director of the university hospitals.

A PROFESSORSHIP in industrial chemistry has been established at Cornell University in honor of Herbert F. Johnson, supported by S. C. Johnson and Son, In-

corporated, Racine, Wis., of which Mr. Johnson was president. The first holder of the professorship will be Dr. Fred H. Rhodes, since 1920 professor of chemistry and chemical engineering, and since 1938 director of the School of Chemical Engineering at the university.

Dr. Francis J. Gerty, clinical professor and chairman of the department of neurology and psychiatry of the School of Medicine of Loyola University, Chicago, has been appointed professor and head of the department of psychiatry at the College of Medicine of the University of Illinois. He succeeds the late Dr. Harold Douglas Singer.

Professor Frederick Slocum, director of the Van Vleck Observatory and for twenty-five years a member of the faculty of Wesleyan University, has been appointed professor emeritus, effective at the close of the college year. He will continue to direct the observatory and to teach two courses during the coming academic year.

Dr. D. P. Curry, assistant chief health officer at Balboa, C. Z., an authority on tropical sanitation and mosquito control, retired on June 1, after more than twenty-two years' service in the Health Department of the Panama Canal.

Howard F. Hopkins, associate regional forester of the California Region, has been appointed from June 1 chief of the Division of Private Forestry Cooperation in the Forest Service. The position has been vacant since last October, when Gerald D. Cook resigned to enter private business.

Dr. Theodore Carroll Byerly, professor of poultry husbandry at the University of Maryland, has been appointed senior poultry husbandman to direct poultry husbandry investigations in the Bureau of Animal Industry of the U. S. Department of Agriculture. He succeeds on July 1 Berley Winton, who recently became director of the U. S. Regional Poultry Research Laboratory at East Lansing, Michigan.

The *Journal* of the American Medical Association states that Dr. Henry R. Kraybill, since 1926 professor and head of the department of agricultural chemistry at Purdue University, has been appointed director of the department of scientific research of the American Meat Institute. He succeeds Dr. Winford Lee Lewis, who has held the position since 1924 and who has asked to be relieved because of ill health. He will be associated with the institute in an advisory capacity.

Dr. G. Herter, formerly of Montevideo, known for his work on the flora of Uruguay, has been appointed director of the Botanical Institute of Cracow, Poland.

The fourth group of scientific men representing the National Research Committee left for London on June 7 to gather scientific data relating to national defense. The party consisted of Dr. George B. Kistiakowsky, professor of physical chemistry at Harvard University; Dr. W. A. Noyes, Jr., professor of physical chemistry at the University of Rochester, and Dr. Robert C. Elderfield, professor of organic chemistry at Columbia University. Dr. Norman F. Ramsey, associate in physics at the University of Illinois, left on June 10 to join the group in London.

Dr. Cassius W. Curtis, assistant professor of physics at Western Reserve University, will be for the next four months engaged in research in physics for national defense purposes at Princeton University under the auspices of the National Defense Research Council. The council has an experimental station at Princeton, and has called together a group of physicists for the investigation of a special problem, the nature of which has not been made public. Other men in the group who have leave of absence and who are taking part in the investigation are Professor H. P. Robertson and Professor Walker Bleakney, of the university; Professor T. A. Beth, of Michigan State College, and Assistant Professor C. W. Lampson, of the University of Richmond.

Dr. Omar C. Held, of the Naval Reserve, associate professor of psychology at the University of Pittsburgh, and personnel assistant to the dean of the college, has been called to active duty with a neuropsychiatric unit in connection with the Naval Operating Base at Norfolk, Va.

The State Department has awarded a travel grant to Dr. Henry K. Beecher, of the Harvard Medical School and the Massachusetts General Hospital, to give a series of lectures during June and July at the National University of Colombia at Bogota.

Dr. Carl V. Weller, professor of pathology of the Medical School of the University of Michigan, delivered on May 8 the twenty-fourth annual Mellon Lecture sponsored by the Society for Biological Research of the University of Pittsburgh. His subject was "The Inheritance of Retinoblastoma and Its Relationship to Practical Eugenics."

Dr. Charles D. Snyder, of the School of Medicine of the Johns Hopkins University, gave on May 15 an address before the annual meeting in New York of the National Gastroenterological Association on "Recent Advances in the Physiology of the Liver and their Challenge to the Experimental Physiologist."

Recent lectures under the auspices of the department of geology and geography at Northwestern Uni-

versity are: Professor Nevin M. Fenneman, of the University of Cincinnati, "Desert Forms and Desert Processes"; Dr. Harrison Schmitt, consulting geologist, "The Training of the Mining Geologist"; Professor H. E. McKinstry, of the University of Wisconsin, "Structural Control in Certain Australian Gold Districts"; Professor E. S. Bastin, of the University of Chicago, "Silver Ores as Illustrations of Problems of the Mining Geologist"; Theron Wasson, chief geologist, Pure Oil Company, "Petroleum Prospecting Methods in Latin America"; Dr. Sherwin F. Kelly, consulting geophysicist, "Magnetic and Electrical Technique in the Mining and Petroleum Fields"; and Dr. H. K. Gloyd, director of the Chicago Academy of Science, "Desert Ecology."

Nature states that in a written reply to a Parliamentary question on April 29, Mr. Butler, Under-Secretary for Foreign Affairs, said: "After consultation with the appropriate authorities in the United States, His Majesty's Government have drawn up a comprehensive scheme, which has already been put into operation, for cooperation in scientific matters with the United States of America. His Majesty's Government have selected and sent Dr. Darwin, the director of the National Physical Laboratory, as director of a Central Scientific Office, working under the direction of the British Supply Council in North America. Dr. Darwin's duty will be to collaborate with United States research bodies, to act as a channel for the exchange with the appropriate United States authorities of technical and scientific information, and generally to coordinate scientific and technical inquiries to and from the United States authorities, except in those matters which are already dealt with through the Service attachés. In addition, Dr. Conant, the president of Harvard University, recently visited England as President Roosevelt's representative in order to establish a corresponding mission in this country."

DR. C. A. WEATHERBY writes to the *American Fern Journal* calling attention to the publication of a new periodical entitled *Natura* published in Japanese and Portuguese by the Kanihara Institute of Natural Science of Brazil at São Paulo. The first installment of a "Flora Nippo-Brasiliensis" appears in this issue.

DISCUSSION

ORIENTAL RAT FLEA ESTABLISHED IN KANSAS

THE occurrence of the oriental rat flea, *Xenopsylla cheopis* (Roth.),[1] in Kansas was reported at the 1941 meeting of the Kansas Academy of Science.[2] This report was based upon 20 fleas from eight rats, *Rattus n. norvegicus* (Erxleben), taken in September, 1940, at the Manhattan city dumping ground. Whether or not fleas of this species could overwinter at Manhattan was problematical, as there have been but few instances in which these fleas have been reported in both the fall and the spring from the same location in the interior of the United States. To test the ability of *X. cheopis* to overwinter at Manhattan, Kansas, another group of adult rats was taken on April 24, 1941, at the city dumping ground. Each of the four rats obtained was infested with from two to eight fleas. On examination, all the fleas were found to be *Xenopsylla cheopis* (Roth.), thus indicating that the oriental rat flea can overwinter at Manhattan, Kansas, and that it is established here.

While *Xenopsylla cheopis* figured in the losses of millions of human lives from bubonic and other types of plague during the period from the sixth to the nineteenth centuries, its greatest importance in the interior of the United States is probably in connection with sylvatic plague, a type that occurs mostly in wild rodents. In recent years, several fatal human cases have been reported. According to Eskey and Haas,[3] sylvatic plague is spreading eastward from western United States. Since 1900, when it was first discovered in the United States at the port of San Francisco, sylvatic plague has been reported from the following interior states: Arizona, Idaho, Montana, New Mexico, Nevada, Utah and Wyoming. These reports include territory east of the Great Divide in New Mexico and Wyoming. That the oriental rat flea, which has been present in coastal cities since 1900, is spreading into the interior has been shown by a number of reports. Trembley and Bishopp[4] listed the following interior states from which *Xenopsyllus cheopis* has been reported: Indiana, Iowa, Minnesota, Illinois, Ohio and Tennessee. The presence of the oriental rat flea in these states and in Kansas, as here reported, and the eastward movement of sylvatic plague, a fatal human disease, make it evident that steps should be taken to control this important pest. While ground squirrels, mice and cottontail rabbits may harbor *Xenopsyllus cheopis*, the principal hosts of this flea are species of rats of which the common gray rat, *Rattus n. norvegicus* (Erxleben), is the most important.[5] These animals are also susceptible to the plague organism,

[1] Identification confirmed by Dr. H. E. Ewing, Bureau of Entomology and Plant Quarantine, Washington, D. C.

[2] A. W. Grundmann, H. P. Boles and J. E. Ackert, *Trans. Kans. Acad. Sci.*, Vol. 44 (in press).

[3] C. R. Eskey and V. H. Haas, *Public Health Rpt.* 54: 1467–1481, 1937.

[4] Helen Louise Trembley and F. C. Bishopp, *Jour. Econ. Ent.*, 33(4): 701–703, August, 1940.

[5] W. B. Herms, "Medical Entomology," 3rd ed., New York: Macmillan, 1939.

Pasteurella pestis (Leh. and Neu.), and could therefore act as a potential menace for the spread of the disease to the common rat. Campaigns against rats in Kansas and other states in which *X. cheopis* is known to occur would thus serve interests of public health as well as economy.

J. E. ACKERT
H. P. BOLES
A. W. GRUNDMANN

KANSAS STATE COLLEGE

JOURNALS FOR LATIN AMERICAN COUNTRIES: A CHALLENGE TO SCIENTIFIC SOCIETIES[1]

THE suggestion is frequently made that we in the United States might help in building hemisphere solidarity through the international language of science, and a good suggestion it is. Our scientific societies publish hundreds of journals, and why shouldn't they help in one way or another to further our widely proclaimed policy of being the "good neighbor"?

The *"Handbook of Scientific and Technical Societies and Institutions of the United States and Canada"*[2] lists over 900 such groups for the United States and its dependencies, and nearly 150 for Canada. Of this number well over 100 are sufficiently national in scope to "go Pan American" quite readily. In the latter group there are approximately 60 societies in the field of medicine, 40 in animal and plant science, and smaller numbers (groups with large memberships, publishing splendid journals) in chemistry, physics, geography, geology, etc. So, here we are with at least 100 to 150 scientific organizations potentially ready to send their journals and their scientific good-will to Latin American countries.

The result of a survey of the present circulation of 21 of our biological and chemical journals (late 1940) appears in the accompanying table. It will be seen that the chemical journals go south in larger numbers than the others. In general, the countries not mentioned are receiving about as many journals as the countries listed. Biological societies publishing the journals indicated have memberships of about 500 to 1,500, and the American Chemical Society approximately 25,000: thus, as far as scientific societies are concerned, the present circulation of their journals is not greatly different for the different groups, on a per member basis. The surprising thing is the small number of journals going to the 16 countries indicated. Even *Biological Abstracts,* the only comprehensive biological abstracting journal of its kind, has but 34 subscriptions going to the countries mentioned. It is reasonable to assume that there are either relatively few workers in the biological field in Latin America, or that they are not sufficiently well acquainted with our societies or journals to find them useful. A further possibility is that many of those who might be interested, can not afford to take our journals because of the relatively high subscription rates (exchange).

JOURNAL		Argentina	Bolivia	Brazil	Chile	Colombia	Costa Rica	Ecuador	Guatemala	Honduras	Mexico	Panama	Paraguay	Peru	Surinam	Uruguay	Venezuela
American Journal of Botany	P	2		1							1	1		1			
	I	4		7													
Botanical Gazette	P			1													1
	I			7													
Bulletin of the Torrey Botanical Club	P	4		1	1	1										1	2
	I	3		1													
Journal of Bacteriology	P	3		2		3					3	2					2
	I	3		8	3	3	1		1		3			2			
Phytopathology	P	12		9		1		1							1		1
	I	16		8	1	2				1				1	1	2	2
Plant Physiology	P			1							1						
	I	3		5													2
Ecology	P	4		2													
	I	3		9							1			1			
Endocrinology	P	22		11	5	7			1		2						2
	I	7		11	6		1				5			1			
Genetics	P	4		2										1		1	
	I	1		10										1			1
American Journal of Anatomy	P															1	
	I	1		3	2	1											
American Journal of Physiology	P	4		0	3			1								1	
	I	2		4	3	1								1			
American Journal Physical Anthropology	P	2		2										2			
	I	1		2	1						2			1			
Anatomical Record	P	1		1	2											1	
	I	1		2	2												
Journal of Comparative Neurology	P	2		2				1									
	I	2		2													
Journal of Nutrition	P	5		2	1									1			
	I	5		4	3		1				1	1					2
Physiological Reviews	P	8		2	4									1		3	2
	I	3		3	2	1											1
Chemical Abstracts	P	38		17	6	4	2	1	2		31		1	6		1	6
	I	40		29	2	2					11			3		5	4
Ind. & Eng. Chemistry (Science Edition)	P	60	2	37	15	6	2	2	4	1	55		1	13	1	3	15
	I	51		32	14	5		1		1	23			5	1	8	8
Ind. & Eng. Chemistry (News Edition)	P	49	1	28	15	9	2	2	4	1	49		1	10		2	15
	I	45		20	10	4		1		1	18			3		6	8
Journal of the American Chemical Society	P	20	1	16	8	2	2	1	1	1	27			7		1	7
	I	17		11	4	1				1	11			2		3	5
Proceedings of the National Academy of Science	P																
	I	3		3		1											

P = PERSONAL SUBSCRIPTIONS
I = INSTITUTIONAL SUBSCRIPTIONS

FIG. 1

Here are a few suggestions, some of which might

[1] The data on journal circulation are presented with the permission of those concerned; their cooperation is gratefully acknowledged.

[2] Bulletin No. 101, National Research Council, Washington, D. C. 283p. 1937.

be carried out to strengthen the cultural ties between the peoples of this hemisphere:

1. Societies in a position to do so might well follow the example of others which in the last few months have invited Latin American colleagues to become members.

2. In order to partly compensate for certain wide differences in exchange, societies in a strong position might establish membership or subscription rates in the various currencies of Latin American republics.

3. Societies might arrange with similar organizations in Latin America for a certain number of exchange memberships. In such memberships international remittances would be unnecessary; exchange-society members would pay larger dues and be allotted a second copy of a journal to be mailed to an exchange member in Latin America (who would be doing similarly). The main point in this suggestion is that no money would change hands, *i.e.*, differences in exchange would not be a problem.

4. Societies might well turn their attention toward the election of corresponding members from Latin America; wherever possible, at least one from each country.

5. Wherever the number of subscriptions for particular journals warrants, (certainly none at present) Spanish or Portuguese abstracts might appear at the ends of all articles. This would be costly, however, unless translations could be arranged on a volunteer basis. It would be equally desirable to a great many United States scientists to have abstracts in English for articles in journals published in Spanish or Portuguese.

The foregoing and other ideas can be successful only if worked out on a *reciprocal* basis. A "big brother" movement is unlikely to be greeted kindly, however cordially it is intended. During the previous World War, one of our generous-minded scientific institutions sent a large number of subscriptions to Latin America, and continued them without charge for a period of years. Less than 10 now remain on their paid circulation list. Possibly this represents the number of scientists who find the journals useful. In any case, it is clear that whatever is done along the line of scientific cooperation, must be done on a basis of equality: no handouts given, and none asked, but always a willingness and a desire for full cooperation.

Our aim ought to be to place our journals in the hands of all our Latin American colleagues who want them and who might profit by them; it is equally important that we have access to such of their journals as in turn would be of value to us. Working out the means for such collaboration is necessarily up to scientific societies and others interested. Such groups can, if they wish, lead the way in strengthening cultural ties between countries of the Western Hemisphere.

And to what organizations shall we turn for leadership?

GEORGE S. AVERY, JR.[3]

CONNECTICUT COLLEGE

THE DISTRIBUTION OF AMERICAN ASTRONOMICAL LITERATURE ABROAD

THE Committee for the Distribution of American Astronomical Literature Abroad was formed in September, 1940, by action of the council of the American Astronomical Society. Because of the risk of loss in passage most ordinary mailings of printed matter from the United States to Europe have ceased. Our committee is therefore sending to European countries one or two copies of each current American publication by whatever seems the safest method and the most promising route.

We have established contacts with a number of European astronomers, who have offered to act as circulation managers for their countries. Dr. Oort in Leiden is circulation manager for Holland, Dr. Delporte for Belgium, Dr. Abetti for Italy, Dr. Kopff and Dr. ten Bruggencate for Germany, Austria, Poland and Czecho-Slovakia, and Dr. Lindblad for Scandinavia. We are not yet mailing regularly to Dr. Lindblad, since the Scandinavian astronomers are apparently still receiving American publications. We have so far been unable to establish contacts with France. An attempt to work through Dr. Mineur failed, and we are now trying to get in touch with the director of the Paris Observatory. The astronomers in Holland and Germany are helping us establish contacts with France and we are certain that before long we shall be able to include France in our scheme. All items are now being sent by second-class registered mail. The losses in transit have so far been small.

In return Dr. Oort, Dr. Abetti and Dr. ten Bruggencate have promised to send by airmail abstracts of all astronomical articles that can not be sent directly to the United States. The committee proposes to mimeograph these abstracts for distribution among American astronomers. The first bulletin with a series of abstracts sent by Dr. Abetti is now being issued. If it should become impossible to send any printed matter to Europe, the committee proposes to prepare similar abstracts of American papers for distribution to Europe.

Most astronomical publications are still being mailed to the British Isles. The committee has, however, begun to send to the secretary of the Royal Astronomical Society one or more copies of those papers that are not being mailed generally to Great Britain. The secretary of the Royal Astronomical Society will also receive at least one copy of every publication from continental Europe that can be spared in the United

[3] Formerly secretary of the Botanical Society of America.

States. We have asked the European circulation managers to provide us for this purpose with extra copies of articles published in their countries. A complete series of recent numbers of the *Bulletin* of the Astronomical Instituts of the Netherlands has already been mailed to England; another set has gone to Canada.

The council of the Royal Astronomical Society has accepted the offer of our committee to send on to the circulation managers in continental Europe copies of current British publications. Eight copies of a recent issue of the *Monthly Notices* of the Royal Astronomical Society and some of the Publications of the Dominion Astrophysical Observatory have already been sent on in this way.

Directors of observatories and editors of astronomical journals are urged to send to the committee a dozen copies of every publication for distribution abroad. The committee is already receiving the generous cooperation of the editors of the *Astrophysical Journal*, the *Publications of the Astronomical Society of the Pacific*, *Popular Astronomy* and the *Telescope*. A small grant from the American Astronomical Society is paying for the current costs of mailing, but the committee will have to ask for further support if it is to continue its work beyond the summer.

B. J. Bok, *Chairman*
H. R. Morgan
J. Stokley

SCIENTIFIC BOOKS

VITAMINS

What Are the Vitamins? By Walter H. Eddy. iii + 247 pp., with six illustrations. New York: Reinhold Publishing Corp. 1941. $2.50.

With the tremendous increase in our knowledge of and interest in vitamins a large number of books on this subject are appearing. Most of these books may be grouped into two large classes: those which give a very complete and detailed picture of one vitamin, such as Williams and Spies on Vitamin B_1 and Reed, Struck and Stick on Vitamin D, and those which contain only the significant facts about all the vitamins. "What Are the Vitamins?" by Eddy falls into the latter class and, as the author states, it is the result of his personal effort to condense the subject of vitamins without sacrificing accuracy. With the exception of a few minor errors the author has accomplished the task he set for himself.

After two introductory chapters, which contain an excellent list of the known vitamins and a brief outline of the relation of vitamins to enzymes, each individual vitamin is discussed. In each case a complete description is given of the various symptoms which one may expect to find during a deficiency of the vitamin in question. Some attention is given to the daily human requirements for each of the vitamins, but the survey of the experimental evidence upon which these figures are based is not extensive. A fairly complete table of vitamin values of foods is given in the appendix.

There is some repetition in the book since chemical formulae for the same vitamin appear in several different parts of the book. Each chapter contains a fairly complete bibliography, although in a few cases papers referred to do not appear in the references. The author seems to have some difficulty in getting the structural formulae exactly correct. On page 66 a CH_2 group is omitted from the thiamin molecule and on page 119 the formula for the hydroxy acid part of pantothenic acid is somewhat deformed.

Any one interested in obtaining the latest information about vitamins in the shortest time possible will do well to consult this book.

C. A. Elvehjem

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COMMERCIAL TIMBERS

Commercial Timbers of the United States, Their Structure, Identification, Properties, and Uses. By H. P. Brown, professor of wood technology, New York State College of Forestry, and A. J. Panshin, assistant professor of forestry, Michigan State College. First edition. 554 pages, 387 figures. New York: McGraw-Hill Book Company. 1940.

This book, which supersedes the "Identification of the Commercial Timbers of the United States" by the same authors, is another addition to the growing list of the American Forestry Series of books which are prepared under the guidance of Professor Walter Mulford, University of California, as consulting editor. It is intended, as the authors say, for use by students in forestry and plant anatomy and also by others who wish to become thoroughly conversant with wood.

It covers the anatomy of wood beginning with the grosser features visible with the unaided eye, such as sapwood and heartwood, annual rings, pores, resin canals, grain and texture, and leading the student into the finer structure visible only with a microscope, such as the shape, size and configuration of the different types of cells found in wood, and briefly into the ultramicroscopic conceptions of the cell wall as determined by x-ray diffraction. The general discussion of wood anatomy is not limited to native species but has universal application.

In addition to the discussion on anatomy, ten pages

are devoted to color, luster, odor, taste, weight and hardness with particular reference to their aid in wood identification.

The part dealing with the identification of species is limited to those of native origin but includes a larger number of genera than other publications on the same subject. Two identification keys of the dichotomous type are provided, one for use with a hand lens and the other for use with a microscope.

As a result of the conservative nature of wood no attempt is made in many cases to carry the identification any farther than the genus or a group of species within a genus. Only in a limited number of cases can the individual species be identified by the wood alone. For example, the numerous species of deciduous oaks are classified into only two groups, the red oaks and the white oaks, and the southern pines are grouped under one head without distinction as to species. Although the wood of two closely related species may show no single reliable diagnostic feature, the possibility of distinguishing species by means of a statistical combination of several features of the wood that show slight variation in averages or extremes has not yet been thoroughly investigated and may some day open up a new field of research in wood structure.

A large part of the text is devoted to descriptions of the wood of over 80 native species covering the gross and minute structure, a brief discussion of properties and principal uses with reasons for such uses. This part, no doubt, would be of interest to engineers, architects, manual training instructors, lumbermen and woodworkers who want more than a superficial knowledge of the various species of wood.

The text is amply illustrated throughout. The key based on gross features is accompanied by illustrations of cross sections magnified 5 times of 86 species and several tangential views natural size. The key based on minute features is accompanied by 32 photomicrographs of special microscopic diagnostic features. Photomicrographs of transverse and tangential sections of 92 species magnified 75 times accompany the descriptions of the different kinds of wood.

A chapter on figure in wood classifies and describes the more common types of ornamental figure found in lumber and veneer, and a chapter on defects gives their definitions, causes, if known, and detrimental effects.

The book is strictly a scientific publication. Technical terms are freely used, as should be the case in a student's manual, but they are carefully defined. The terminology used follows principally that adopted by the International Association of Wood Anatomists several years ago. A glossary of technical terms is appended. The language of the text is in a free-flowing, simple, narrative style which makes it easy to read. Only occasionally do the authors indulge in the use of "high-brow" nontechnical words, but that should not only be excusable but even justifiable in a college textbook.

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SOIL PHYSICS

Soil Physics. By L. D. BAVER. New York: John Wiley and Sons, Inc. London: Chapman and Hall, Ltd. ix + 370 pp. $4.00.

AT long last there is available a satisfactory work on soil physics written primarily for use as a text-book for advanced undergraduates and graduate students in agricultural colleges. It is the only book on soil physics that has come to the writer's attention since Keen's "Physical Properties of the Soil" appeared some ten years ago. The new edition of Keen announced over a year ago is reported to have been delayed.

Baver's text is essentially a comprehensive review of carefully selected material from the extensive literature of soil physics research. Conclusions and the interpretation of results are stressed, with less attention being given to apparatus and methods. A liberal list of references is given at the end of each chapter. Frequent reference is made to the pioneer work in soil physics of the last century, particularly to Wollny, whose contributions to soil science should receive more attention than they now do. The book is written from the agronomic viewpoint, there being little material upon the engineering aspects of soils other than those pertaining to soil conservation. A few topics dealing with mathematical operations and thermodynamic processes are not presented with the conciseness and precision desired by some physicists perhaps, but in the manner which the author, in his nine-year experience in teaching the subject, has found to be best suited to soils students.

The subject-matter is divided into ten chapters. After an introductory chapter, largely of a historical character, the author takes up the mechanical composition of soils and the physical characteristics of soil colloids. Next is a chapter on soil consistence and then one on soil structure, the longest in the book, with many references to Russian work. Unfortunately the simple soil structure and soil consistence classifications of Nikiforoff were omitted. Chapters on soil water, soil air and soil temperature are followed by two chapters on some physical and technological aspects of tillage and soil erosion.

Teachers and students of soil physics will appreciate

this book as a valuable time-saver, and agronomic workers will find it interesting and useful. Those who do not have ready access to all foreign soil science periodicals will appreciate the summaries of the important work of Russian, German and French soil physicists. The book is particularly timely and its acceptance is assured.

L. B. Olmstead

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SOCIETIES AND MEETINGS

THE VIRGINIA ACADEMY OF SCIENCE

The nineteenth annual meeting of the Virginia Academy of Science was held at the Medical College of Virginia, Richmond, from May 1 to 3, with 520 in attendance; 197 papers were presented in the 11 sections, a new one in forestry having been formed this year. Dr. John H. Yoe and Dr. Lyle G. Overholzer were awarded the Interacademy Award of $100 for their paper, "Application of a New Class of Organic Reagents to the Detection and Determination of Palladium." Dr. Allen T. Gwathmey won the Jefferson Award of $50 with his paper, "The Action of Some Gases on the Surface of a Single Crystal of Copper." The Academy Award of $50 was won by Mr. Charles Ray, Jr. His paper was entitled "Cytological and Genetic Studies on the Flax Genus, Linum." All recipients of awards are on the staff of the University of Virginia.

Austin H. Clark, curator, Division of Echinoderms, U. S. National Museum, and president of the Washington Academy of Sciences, was the principal speaker at the banquet and at the organization meeting of the Junior Academy of Science.

The first report of the newly formed Long Range Planning Committee of the Academy recommended that two projects receive special attention during the coming year—the Junior Academy and science clubs and the James River monograph.

Officers elected were Dr. George W. Jeffers, Farmville State Teachers College, *President;* Dr. E. C. L. Miller, Medical College of Virginia, *Secretary-Treasurer;* Dr. Sidney S. Negus, Medical College of Virginia, *Assistant Secretary;* Dr. Marcellus H. Stow, Washington and Lee University, *President-elect,* and Dr. Harvey B. Haag, Medical College of Virginia, *new member of the Council.*

After the academy meeting closed, 135 of those in attendance took a trip into Dismal Swamp, while others visited the bogs at Petersburg and Seward Forest.

There were 203 science club members from over the state present at the first formal meeting of the Junior Academy of Science. Honorary junior memberships in the American Association for the Advancement of Science were awarded to Gordon Jones and John Tompkins jointly, of Mt. Vernon High School, Arlington, in recognition of their exhibit of plants displayed at the meeting and to Forrest Pitts, of Thomas Jefferson High School, Richmond, for his excellent showing in the radio quiz held in connection with the meeting. Miss Lena Artz and Miss Martha H. Lipscomb are respective sponsors of the science clubs in these two high schools. Honorary junior memberships in the Virginia Academy of Science were awarded to Martin Milroy, Randolph Henry High School, Charlotte Court House, Miss Lyndele A. Pitt, sponsor; Walter Brown, Lane High School, Charlottesville, Mr. W. I. Nickels, Jr., sponsor; and Miss Patsy Whitaker, Pulaski High School, Pulaski, Miss J. Frances Allen, sponsor. These three young people were selected becaues of their outstanding work during the year in science club work.

Besides Mr. Clark, Miss Margaret E. Patterson, of the American Institute of the City of New York, spoke to the Junior Academy group. Hubert J. Davis, of the Matthew Whaley High School, Williamsburg, acted as chairman of the meeting.

A. J. Davis, of the Test Tube Tinkerers Science Club of George Washington High School, Danville, was elected president of the Junior Academy for the ensuing year. Miss Patsy Whitaker, of the Roy Chapman Andrews Museum Club, Pulaski High School, was elected vice-president, and Miss Catherine Christian, of the Einstein Club, Appomattox High School, was chosen secretary.

E. C. L. Miller,
Secretary

THE PENNSYLVANIA ACADEMY OF SCIENCE

The seventeenth annual meeting of the Pennsylvania Academy of Science was held on April 11 and 12 at Coatesville. During the sessions 175 persons registered as senior academy members and 161 registered in the Junior Academy. General meetings for the presentation of papers were held on Friday and Saturday mornings. On Friday afternoon the program was split into three section meetings, one on meteorology that had been arranged by the Central Pennsylvania Seminar of American Meteorological Society, one on geology and one devoted to the teaching of science and general papers. The Junior Academy met simultaneously under the direction of Professor Karl F. Oerlein. The annual dinner was held on Friday eve-

ning and was followed by an address by W. G. Theisinger, director of welding research, Lukens Steel Company, on "The Science of Making Steel and Steel Defense Products." This lecture was illustrated by colored moving pictures taken in the mills of the Lukens Steel Company.

At the business meeting on Saturday the following officers were elected: *President,* E. A. Vuilleumier, Dickinson College, Carlisle; *President-elect,* Charles E. Mohr, the Academy of Natural Sciences, Philadelphia; *Vice-presidents,* Marcus H. Green, Albright College, Reading, and Thomas H. Knepp, Everett High School; *Secretary-Treasurer,* V. Earl Light, Lebanon Valley College, Annville; *Editor,* Robert T. Hance, Duquesne University, Pittsburgh; *Press Secretary,* Lawrence Whitcomb, Lehigh University, Bethlehem; *Junior Academy Adviser,* Karl F. Oerlein, State Teachers College, California.

It was decided that the summer meeting in 1941 would be held at Bedford, Pa., on August 8 and 9, the 1942 spring meeting at State Teachers College, Edinboro, Pa., on April 3 and 4, and the 1943 spring meeting at Beaver College, Jenkintown.

LAWRENCE WHITCOMB,
Press Secretary

THE IOWA ACADEMY OF SCIENCE

THE fifty-fifth annual meeting of the Iowa Academy of Science was held at Simpson College, Indianola, Iowa, on April 25 and 26, with 260 registered members and visitors attending.

A symposium, "Recent Advances in Genetics," with President Charles Carter, of Parsons College, presiding, took the place of the customary Friday morning presidential address. The three topics discussed and the leaders were as follows: "Theoretical Genetics," E. W. Timm, Iowa State College; "Applied Plant Genetics," I. J. Johnson, Iowa State College; "Applied Animal Genetics," J. L. Lush, Iowa State College; "Human Genetics," K. A. Stiles, Coe College. A joint symposium with the Iowa Medical Society, "Virus Diseases," was held on Friday afternoon, with J. W. Gowen, of Iowa State College, in the chair. The topics and leaders were as follows: "The Chemistry of Plant Viruses," C. G. Vinson, University of Missouri; "Experimental Leukosis," C. D. Lee, Iowa State College; "Viruses Affecting the Respiratory Tract of Man," W. M. Hale, Iowa City. The Friday evening dinner address, "Simultaneity and Originality in Human Thought," by Professor George Glockler, of the State University of Iowa, presented a thought-provoking viewpoint to about 180 diners. The annual academy address on Friday night was delivered by C. R. Keyes, of Cornell College. The Iowa audience was quite surprised to learn of the archeological possibilities in the state.

The academy likewise met in 9 sections for the presentation of 141 papers of special interest. The science teaching section held a symposium, "Tests and Measurements in Science." The leaders were D. B. Stuit, State University of Iowa; S. M. Dietz, Iowa State College; and P. E. Kambly, University High School, Iowa City.

Iowa Wesleyan College, Mt. Pleasant, Iowa, will be the host of the academy in 1942. The officers and section chairmen for the new year are as follows: *President,* Roy A. Nelson, Cornell College; *Vice-president,* C. W. Lantz, Iowa State Teachers College; *Secretary-Treasurer,* E. R. Becker, Ames, Iowa; *Editor,* L. R. Wilson, Coe College; botany and bacteriology, M. L. Grant, Iowa State Teachers College; chemistry, general and physical, H. H. Rowley, State University of Iowa; chemistry, organic and biological, Henry Gilman, Iowa State College; geology, L. W. Wood, Iowa State Highway Commission; mathematics, Orlando Kreider, Iowa Falls Junior College; physics, C. O. Gale, Grinnell College; psychology, M. T. Henderson, Grinnell College; science teaching, S. M. Dietz, Iowa State College; zoology, J. A. Adams, Grinnell College.

E. R. BECKER

AMES, IOWA

REPORTS

REPORT OF THE COMMITTEE ON CLASSIFICATION OF MILITARY PERSONNEL ADVISORY TO THE ADJUTANT GENERAL'S OFFICE[1]

THE Committee on Classification of Military Personnel held its first meeting at the National Research Council on May 24, 1940. Subsequent meetings were held on August 9, December 9 and February 23 and 24, 1941. In addition, there has been much individual conference and correspondence with officials in the War Department.

The problems with which the committee has dealt have arisen mainly out of the work of the Personnel Research Section in the Personnel Bureau of the Adjutant General's Office. This section is responsible for developing aids to correct classification of officers and men with respect to their abilities and skills, educational background, civilian and military experience, intellectual capacity, personal qualifications, special aptitudes and indicated best Army usefulness.

[1] Submitted to the Division of Anthropology and Psychology of the National Research Council, April 26, 1941.

The advice of the committee was first sought with respect to plans initiated by the War Department during the winter and spring of 1940 for developing a good classification test for use when recruits and trainees first report to reception centers, a test with which to sift the new arrivals into a few broad groupings with respect to their ability to learn quickly the duties and responsibilities of a soldier. Preparation of such an instrument was placed first on the priority list by Brigadier General (then Colonel) Wm. C. Rose, who mentioned other less pressing problems likely to require the attention of the committee later, including methods of selecting men for training as officers; simplification of officer efficiency reporting; improvement of standardized occupational interviews and tests of proficiency in a trade; and supplementary tests of aptitudes for work which calls for mechanical ingenuity or other special talents. He stated that a preliminary plan had already been made for preparing a classification test which would be reliable, practicable, feasible to administer and useful as a rough indication of trainability.

Captain M. W. Richardson presented the plan which described the purpose of the tests, stated the assumptions which controlled in selection of content, described its mechanical aspects and outlined in detail the successive steps necessary in construction, tryout, item analysis, revision, testing of a large population of troops in order to construct scales and norms, preparation of complete instructions for administration and for use of the scores, training of officers in giving and interpreting the test, and a follow-up check of the validity of the test as an indicator of military usefulness or of subsequent progress made by the recruit in training schools.

The committee recognized that such a test would sometimes have to be administered by people with but little experience in examining, and not by professional psychometrists. The emphasis should be, then, on measuring power, not speed, so that small errors in timing would make little difference in the score. A test rather steeply graded in difficulty from very easy to fairly hard was indicated. Other precautions approved by committee members were that the test should be readily scored by hand, as well as by machine; that it ought not to have an esoteric or puzzle-like appearance, but should appeal to both officers and men as a sensible practical test so that they would take it seriously and have some confidence in the fairness and worthwhileness of the scores. This meant that it must be free from ludicrous items, and items that look childish, schoolish, bookish or otherwise out of place in a test taken by mature men who may or may not have done much reading and writing since their school days.

As to the units in which performance in the test should be expressed, a suggestion offered by Captain Richardson was instantly endorsed, namely, that no use whatever be made of "mental age" units or I.Q.'s or school-grade equivalents; and that efforts be made to discourage any one from attempting to equate scores on this adult test with scores on tests scaled in units of mental age or other inappropriate, misleading and easily misunderstood terms. Instead, it was agreed to endorse the scaling and calibration of the test in units of standard deviation from the average performance of a representative population sample of adult males of military age.

It was deemed advisable to build a test in spiral-omnibus form, with an ample fore-exercise, making use of arithmetical items, verbal items and space items. It was agreed, however, that the test should yield only a single score because of the relative unreliability of part-scores when used for individual diagnosis.

The recommendations of the committee were followed. One form of the General Classification Test, as it is called, was ready for use at Reception Centers when they began to operate in November, and an alternate form, somewhat improved, has since been issued. Army Grades and Standard Scores on this test are now recorded on the Qualification Cards of upwards of a million inductees and enlisted men and are in daily use as aids to personnel officers in classifying and re-classifying men, making initial assignments, balancing units and selecting men for Army training schools or for special duties.

Meanwhile, other instruments for measuring individual differences have been constructed and put to use, including a Non-Language Test, Literacy Tests, a Clerical Aptitudes Test and a Mechanical Aptitudes battery. Follow-up studies are in progress, to enhance the usefulness of such data by providing officers with expectancy tables, critical scores and preferred ranges for the most common types of special training courses. During the construction and validation of these instruments, the advice of the committee has been followed.

The committee's suggestions were also sought with reference to plans for selection and training of personnel officers and personnel technician officers (military psychologists). Recommendations made at the meeting on February 24 have now been approved by the War Department and in the near future will be put in effect, whereby the gateway to such a career will be open to a limited number of professionally and personally qualified selectees who want to fit themselves for one of these army specialties. The plan in brief is as follows:

A training program has been outlined for which approximately 25 psychologists (selectees) will be chosen every three months. The men will be picked

from among the applicants who have the desired professional background and who are deemed to excel in the personal qualities and stamina indicative of success as an Army officer. Selection will be made during the thirteen weeks in which the selectee is getting his basic military training. He will then enter on a period of four or five months of apprenticeship or interneship, assisting classification officers and examiners in the work of interviewing, examining, trade-testing and classifying recruits, filling requisitions, following up the performance of soldiers who seem to need re-classifying or transfer, and the like. Attendance at a central four-weeks school will be provided for during this interneship period, after which the selectees will take the regular three-months course in an officers' training school. If successful here, he will be commissioned in the Officers' Reserve Corps (Adjutant General's Section) and immediately thereafter will have a year of active duty as a personnel technician officer.

It is anticipated that some qualified selectees who are interested in personnel work but who for personal reasons do not wish to commit themselves for a period of two years will nevertheless find their best Army usefulness during a considerable part of their year of selective service training in duties connected with some phase of the Army's personnel program. Some, with superior ability as leaders, will prefer to spend their year in training and duty with combat troops.

In the field of officer classification, studies and recommendations have been made looking toward improvement of the Officers' Efficiency Report. Procedures to be followed in selecting candidates for admission to Officers' Training Schools are also being developed. Several examinations are now in preparation: for Warrant Officers, at the high-school level; and at the college level, for applicants to Officers' Training Schools and for National Guard and Reserve Officers on active duty who want commissions in the Regular Army.

Grateful acknowledgment is made to psychologists who have been generous with their help, including F. L. Wells, of Harvard; R. A. Brotemarkle, of the University of Pennsylvania; R. M. Bellows, of the University of Maryland; Ben D. Wood, of the Cooperative Test Service; R. M. Yerkes, of Yale; E. L. Thorndike and Irving Lorge, of Columbia; Walter Dill Scott, of Northwestern; E. K. Strong, Jr., of Stanford; C. S. Yoakum, of Michigan, and many others.

These are trying days. America may be only arming so that we shall not be attacked during the years ahead; or we may be attacked in the not distant future. In either event, the profession of psychology is shouldering at least a part of its appropriate load. The Committee on Classification of Military Personnel assures the Adjutant General of the Army, Major General E. S. Adams, and the National Research Council of its readiness to carry on.

Respectfully submitted,

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SPECIAL ARTICLES

EFFECT OF LOCAL EDEMA AND INFLAMMATION IN THE SKIN OF THE MOUSE ON THE PROGRESSION OF HERPES VIRUS

HERPES virus, when injected intracutaneously into the abdominal wall[1] or applied by needle puncture to the skin of the tail,[2] induces in the white mouse an ascending myelitis. Hindlimb paralysis is first noted on about the eighth day, followed within 24 to 48 hours by quadriplegia and finally prostration and death. As will be shown in this preliminary report, certain chemicals, introduced into a cutaneous area prior to its exposure to the virus, have an enhancing or retarding effect on the development of this clinical syndrome.

Albino mice, Rockefeller Institute strain, about 30 days old, were used. Four groups of materials were injected subcutaneously into the tails near the base as a preparatory treatment. The materials were: (*a*) hypertonic solutions of inorganic salts (5 per cent. and 10 per cent. NaCl, 10 per cent. NH_4Cl, 14 per cent. NaH_2PO_4, 7 per cent. Na_2SO_4, 16 per cent. KI) or 20 per cent. dextrose; (*b*) isotonic .85 per cent. NaCl, 1.71 per cent. KI, normal rabbit serum or hypotonic distilled water, and (*c*) an irritant, turpentine-ether-olive oil in equal parts. 0.1 cc of one of the substances was injected and at varying intervals thereafter, a superficial skin abrasion was produced at the same site, covering an area of about 7 × 3 mm. A broth suspension of brain and cord infected with the HF strain of herpes virus was then applied to the entire abraded area and gently rubbed in by means of the shank of the needle.

Table I shows the results obtained in a typical ex-

[1] H. B. Andervont, *Jour. Infect. Dis.*, 44: 383, 1929; *ibid.*, 45: 366, 1929.
[2] F. O. Holmes, personal communication.

TABLE I

Groups of mice	Material injected subcutaneously	HF-virus dilution applied to abraded skin 24 hours later	Number dead / Total number injected	Average time between virus application and death
A	NaCl 10 per cent.	10^{-2}	12/12	6.4 days
		10^{-3}	18/18	7.0 "
		10^{-4}	8/12	7.9 "
		10^{-5}	0/6	...
B (control)	NaCl 0.85 per cent.	10^{-2}	12/18	9.4 "
		10^{-3}	1/18	10.0 "
		10^{-4}	0/12	...
C	Turpentine-ether-olive oil, equal parts	10^{-2}	1/6	10.0 "
		10^{-3}	1/6	9.0 "

periment. Group A mice which received the preparatory treatment with hypertonic 10 per cent. NaCl solution, in comparison with Group B mice which were treated first with isotonic NaCl, revealed the enhancing action of the hypertonic solution. This enhancement was demonstrable in two ways: (1) the titre of virus was one hundredfold greater and (2) the average time between virus application and death was about one third less than when isotonic saline solution was used for the preliminary injection. All other mentioned hypertonic solutions had the same effect as 10 per cent. NaCl, while no difference was noted between animals treated with any of the isotonic materials or distilled water and non-treated control mice. Duration and course of the experimenal disease were not affected, once the clinically apparent infection arose. The results were the same when the interval between injection of the solutions and application of virus was shortened to 3½ and 6 hours. No enhancement was seen, however, when virus was given 1 week after or 24 hours before inoculation of the solutions, or when the two were mixed *in vitro* and injected together. Moreover, the enhancing effect was not elicited when first the chemicals, and later the virus also, were inoculated subcutaneously.

The next step was to compare the action of these enhancing substances with that of turpentine, since King[3] found that this material, when injected into the pad of the mouse, had a retarding effect on the progression of pseudorabies virus from that site to the central nervous system. Table I (Group C) shows similar findings obtained with herpes virus applied to abraded skin. King ascribed the inhibiting effect to inflammation caused by the irritant.

This retarding action, then, would be in contrast to the enhancement brought about by hypertonic substances which produce local edema. In studying the characteristics of local edema and inflammation respectively, it was recalled that Hudack and McMaster,[4] and others,[5] have shown that local edema causes a considerable dilation and increased permeability of the minute lymphatics of the skin, thus leading to greatly increased lymphatic flow and absorption from an edematous area. This type of reaction is in contrast to that characterizing acute inflammation, as brought about by turpentine. A number of investigtors[6] have shown that inflammation is associated with a total or partial blockade of lymphatic channels by thrombi or fibrin clots, thus fixing particles within the inflamed area.

A prerequisite for infection of the central nervous system by herpes virus, postulated by Goodpasture and his associates,[7] is that a sufficient number of nerve fibers be exposed to the virus, whence the virus progresses axonally. A hypothesis is therefore offered to explain the described enhancing and retarding effects of certain substances: the virus may be brought to the nerve fibers in the skin by way of the lymph channels. Hence edema which opens these channels and renders their walls abnormally permeable, and increases the rate of flow, may bring the virus in contact with a greater number of nerve fibers in the corium; while in acute inflammation, total or partial blockade of the lymphatics may prevent or diminish such contact.

The results here reported fit in with this hypothesis: When a mixture of hypertonic solutions and virus was inoculated; when the hypertonic solutions were given after the virus was applied; or when the virus was applied after the edema caused by the solutions had subsided, then the enhancing action of the hypertonic solutions was not observed. Moreover, when the virus was introduced subcutaneously instead of cutaneously, again no enhancement was seen—on subcutaneous injection, the virus comes in contact with relatively fewer lymphatic channels and these not opened by trauma, while on cutaneous application the virus encounters a dense net of lymphatics and these opened by trauma.[8] Further work is in progress.

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[3] L. S. King, *Jour. Exp. Med.*, 72: 573, 1940.

[4] S. Hudack and P. D. McMaster, *Jour. Exp. Med.*, 57: 751, 1933.

[5] B. D. Pullinger and H. W. Florey, *Brit. Jour. Exp. Path.*, 16: 49, 1935.

[6] For experiments and literature, see V. Menkin, "Dynamics of Inflammation." New York: Macmillan Company, 1940.

[7] E. W. Goodpasture, *Medicine*, 8: 223, 1929; E. W. Goodpasture and O. Teague, *Jour. Med. Res.*, 44: 121, 1923.

[8] The richness of the lymphatic plexus in the papillary layer of the corium has been stressed (see footnote 4); also the fact that scarification and the slightest penetration beneath the epithelium opens these vessels to the entrance of particulate matter (see footnote 4).

DIABETIC ACIDOSIS AND COMA IN THE MONKEY

EXAMINATION of the literature reveals only two recent studies on the influence of pancreatectomy in the monkey.[1,2] Both reports emphasize that the monkey does not develop the same degree of metabolic disturbance as occurs in the dog or cat following removal of the pancreas. Thus Collip, Selye and Neufeld state that the monkey can survive pancreatectomy for many months without insulin treatment; that ketonuria, which may be observed during the first few days following the operation, disappears later, irrespective of whether or not the animal is treated; that the depancreatized monkey shows a marked sensitivity to insulin and rapidly develops hypoglycemia on fasting, and finally that such animals lose weight rapidly. Similar observations were made by Chapman and Fulton who concluded that, unlike depancreatized carnivora, depancreatized monkeys do not die in typical diabetic acidosis. Both groups of investigators are of the opinion that the depancreatized monkey resembles in many respects the depancreatized-hypophysectomized dog.

During the past year we have conducted studies on depancreatized monkeys and our observations do not support the above conclusion. Rhesus monkeys were depancreatized under nembutal anesthesia. Within a few hours after the operation, insulin was administered and within twenty-four hours thereafter the animals were given food. Insulin therapy was continued for from a number of weeks to several months and the animals were permitted to eat freely, records being kept of the daily intake. The diet consisted of oranges, bananas and biscuits made with dog ration, pancreatin and ground peanuts. The diet was supplemented with adequate amounts of vitamin A and D concentrate. The insulin dosage was regulated so as to permit the urinary excretion of from 10 to 20 grams of glucose per day. Loss of weight did not occur on this régime. When the weight was stabilized for several weeks, both insulin and food were withdrawn. The blood sugar and acetone body content were determined at frequent intervals thereafter, as was the urinary excretion of these substances.

In this preliminary report we wish to draw attention to a rapid development of acetonemia following the withdrawal of insulin and food from depancreatized monkeys (Fig. 1). The acetonemia was accompanied by a decrease in the carbon dioxide combining power and a decrease in the pH of the blood. The development of the acidosis was accompanied by typical symptoms such as weakness, dehydration, Kussmaul breathing, and tarry vomitus. When the acetonemia

[1] J. B. Collip, H. Selye and A. Neufeld, *Am. Jour. Physiol.*, 119: 289, 1937.

[2] S. W. Chapman and J. F. Fulton, *Am. Jour. Physiol.*, 123: 35, 1938.

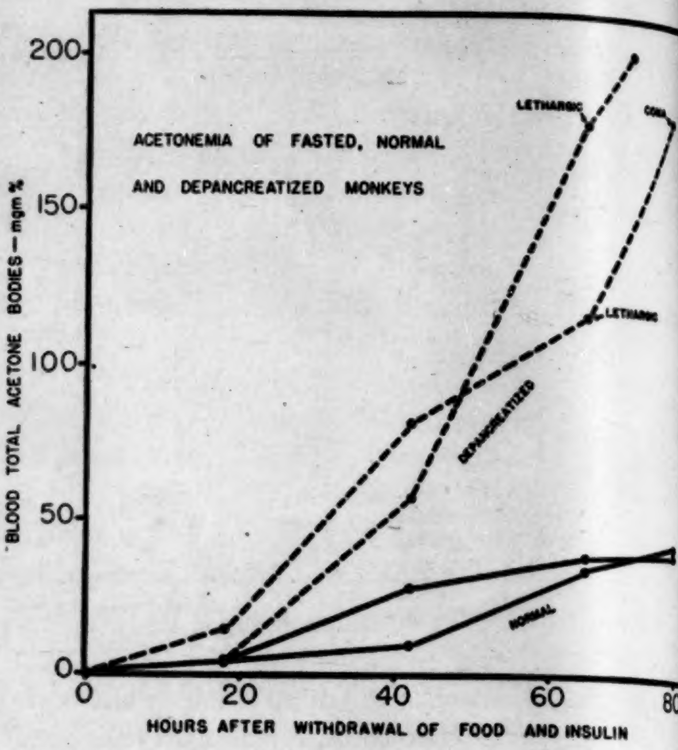

FIG. 1. Illustrating the acetonemia consequent to the withdrawal of food from normal and from depancreatized monkeys after insulin deprivation.

reached about 175 mgm per cent., the animals became lethargic and in one instance a state of coma was present at this blood level.

Fig. 1 depicts the acetonemia of two normal and two depancreatized monkeys subsequent to food and insulin withdrawal. Coma developed in one of the depancreatized monkeys, but insulin was not administered until the monkey had been in this state for 24 hours. The administration of insulin thereafter was ineffective in preventing the death of the animal.

It is obvious from the preceding that the depancreatized monkey can develop a severe acetonemia and the symptoms of diabetic acidosis after insulin withdrawal and that death in typical diabetic coma can ensue if insulin therapy is not instituted at a sufficiently early period of time. The similarity between the syndrome of diabetic acidosis and coma in man and that observed in the monkey is very striking and will be discussed in greater detail in another communication.

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EFFECT OF LIGHT ON GROWTH HABIT OF PLANTS

A POTTED plant of teosinte, *Euchlaena mexicana* Schr., became prostrate under greenhouse conditions at Cornell University, Ithaca, N. Y. When moved to

a dark room it assumed an erect position in a few days. Placed back into the greenhouse it gradually became prostrate again. The seeds from this plant produced seedlings which responded to light in a similar way; they were prostrate in the sunlight and erect in weak light or in darkness. The growth habit could be changed at will by changing the light conditions.

Recently experiments were conducted at the Instituto Experimental de Agricultura, Caracas, Venezuela, to study the effect of light on *Panicum purpurascens*, Raddi.; *Alternanthera ficoidea*, Moq.; *Eleusine indica* (L.) Gaertn.; *Commelina cayennensis*, Rich.; *Portulaca oleracea*, L.; *Mimosa sensitiva*, L.; *Cynodon dactylon* (L.) Pers.; *Plantago major*, L.; *Echinochloa colonum* (L.) Link and others, which normally have a prostrate habit of growth under field conditions. Several plants of each genus which were prostrate in an open field were covered with a low roof of burlap bags or of cardboard boxes. In a few days they started to raise themselves and gradually became erect. When the protective coverings were removed, the plants became prostrate again. Then some of the shoots of each plant were covered and some left exposed to the sunlight. In every case the covered shoots became erect while the exposed ones remained prostrate.

Cuttings were made from prostrate plants and potted in an erect position. After they had taken root, some were placed toward the back of a box 24″ × 18″ × 18″ which was open only to the south, and others were placed in the front of the box. Those in the back received diffuse light, while those near the entrance received direct sunlight from one side only. Plants in the back of the box bent south toward the light, while those in the front bent north away from the light. In other words, the plants in the back row showed positive phototropism, while similar plants in the front row showed negative phototropism.

The experiment was repeated several times, using cuttings of most of the genera mentioned above and similar results were obtained. Young *Commelina* plants reacted quickly to changes in light conditions. The front and back rows curved toward each other as in the previous experiments; but a third row between the other two rows bent forward in the early morning while shaded from the sun by the east side of the box, and bent backward during the middle of the day while exposed to direct sunlight. In late afternoon the west edge of the box shaded the center row again and the plants straightened up. This pattern of growth was followed every clear day. On cloudy days the plants bent forward in early morning and stayed forward all day.

By means of a special apparatus, it was shown that direct sunlight is not necessary to produce negative curvatures; reflected light of high intensity will give similar results but not as quickly.

From these experiments and others which will be described in detail in another publication the author has concluded that certain plants which normally have a prostrate growth habit under field conditions are probably negatively phototropic to intense light. A possible explanation will be given later.

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SCIENTIFIC APPARATUS AND LABORATORY METHODS

A TECHNIQUE FOR CONTINUOUS MICROSCOPIC OBSERVATIONS

THE literature on anaerobic cultivation contains numerous descriptions[1] of apparatuses for the microscopic observation of the developmental processes of organisms requiring a low oxygen tension. The glaring defect in these techniques lies, not in their inadequacy, but in their relatively elaborate and complicated schemes of preparation and utilization.

In the course of the study of the morphology of the butyl alcohol-acetone organism, Mr. Eugene Gaughran, a graduate student in our laboratories, developed a method which, because of its simplicity and effectiveness, we have adopted as a standard technique.

The Gaughran method may be described succinctly as a simple hanging drop preparation in which the air has been replaced by a very inert oil of low viscosity and marked clarity. The oil preferred is a D.T.E. light turbine oil. This completely saturated oil is colorless in thin layers. It may be obtained from any of the large oil companies.

The procedure, which involves no meticulous care and takes less time than an ordinary fixed preparation, is as follows: The cavity of a depression-slide is filled with an excess of freshly heated (sterile) oil. A small portion of a semi-solid culture of the organism to be studied is transferred by pipette from the bottom of the culture tube to the center of a sterilized cover-slip. The cover-slip is inverted over the depression of the objective slide in a manner that will eliminate all

[1] Among the methods tried were those described by the following: M. A. Barber, *Jour. Exp. Med.*, 32: 295, 1920. H. Buchner, *Centbl. Bakt.* (etc.), 4: 149–151, 1888. J. Fortner, *Centbl. Bakt.* (etc.), 1 Abt. Orig. 108: 155–159, 1928. J. Fortner, *Centbl. Bakt.* (etc.), 1 Abt. Orig. 115: 96–99, 1929–1930. A. Itano and J. Neill, *Jour. Infect. Diseases*, 29: 78–81, 1921. H. Neumann, *Centbl. Bakt.* (etc.), 1 Abt. Orig. 114: 228–232, 1929. M. van Riemsdijk, *Centbl. Bakt.* (etc.), 1 Abt. Orig. 143: 265–270, 1939. L. Wamoscher and J. Vasarhelyi, *Centbl. Bakt.* (etc.), 1 Abt. Orig. 123: 250–255, 1932.

bubbles of air. The excess oil will be displaced to form a perfect seal. Immediately, the liquid portion of the medium spreads out between the oil and the cover-slip and the more solid portion of the medium is held firmly in place. The reason for this is apparent when one considers the free surface energy of the system in the light of the high surface tension and low adhesion tension of the oil and the relatively low surface tension and high adhesion tension of the solution in preferentially wetting the glass.

The practice of placing the chamber on the microscope stage and then placing the whole apparatus in an incubator was found to be objectionable. In a prolonged observation of a specific germinating spore or a dividing cell, any movement of the microscope will cause the organism to be carried from the field by the fluid flow or to gravitate. The many warm stages previously described in the literature were found to be unnecessary. In this method, the substage mirror is removed and a standard frosted 40-watt electric light bulb resting on a sheet of asbestos is inserted into the horseshoe base of the microscope. This is capable of providing the optimum temperature ($37 \pm 2°$ C.) for the germination of the spores of the butyl alcohol-acetone group of anaerobes. For other organisms the required temperature can be obtained by changing the distance between the bulb and the stage or by using bulbs of varying intensities.

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ATTEMPTS AT TAGGING SMALL SALAMANDERS IN LIFE HISTORY STUDIES

AMONG the vertebrates, with the exception of small salamanders, fairly satisfactory methods of marking individuals for ready future identification are known. Jaw-tags probably will be satisfactory for tagging larger individuals of such species as *Cryptobranchus* and *Necturus* as they have proved to be with frogs.[1] However, the writer is not aware of any satisfactory tag, commercial or otherwise, which may be used to encircle the jaw of such small salamanders as *Triturus, Desmognathus, Plethodon, Eurycea,* etc. The failure of another method is recorded here, namely, that of inserting a clip through the musculature of the back or tail.

On July 28, 1939, at the Edmund Niles Huyck Preserve, Rensselaerville, New York, a number of adult newts, *Triturus viridescens viridescens,* averaging 95 mm in total length, were tagged with small surgeon's suture clips. These clips are smaller and considerably lighter than any of the commercial types of strap tags which are now on the market. However, they can not be bent over and locked at the tip. Clips were placed on the newts at various points such as through the musculature of the lower hind leg and about the jaw. They appeared at once to be much too large and heavy and when the newts were liberated in an aquarium they were quickly carried to the bottom and were able to reach the surface again only by great effort. The most satisfactory point to attach them appeared to be through the dorsal part of the tail muscles back of the anus. A few were also marked by inserting a clip through the musculature of the back just anterior of the anus. Several tagged specimens were placed in an aquarium and 17 were liberated in a small pond in a bed of emergent grasses near shore where they had originally been obtained.

After five days this grassy area was seined and several specimens were recovered very close to the spot where they had been liberated. Only one newt which had been tagged through the muscles of the tail was holding the clip securely. In five other recovered newts it had either pulled out, leaving a large hole in the tail or back, or was very loose, and the nearby flesh had a putrid appearance. The entire tail, posterior to the point of attachment of the suture clip, had dropped off in one newt. The tagged specimens placed in aquaria had lost their tags.

Dr. William C. Senning tagged over 500 *Necturus maculosus maculosus* in a limited area in Cayuga Lake near Ithaca, New York, by inserting strap-tags through the muscles of the tail near its base. These tags held well for at least two weeks, the period over which the actual tagging was done. After a lapse of two years the area was collected again, but no tagged *Necturus* were recovered, although many specimens were taken. It can not be assumed that the *Necturus* lost their tags since the marked specimens may have moved out of the area. However, in the absence of evidence to the contrary the success of this method of tagging must be viewed as questionable with *Necturus.*

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[1] E. C. Raney, *Amer. Midl. Nat.,* 23: 733–745, 1940.

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